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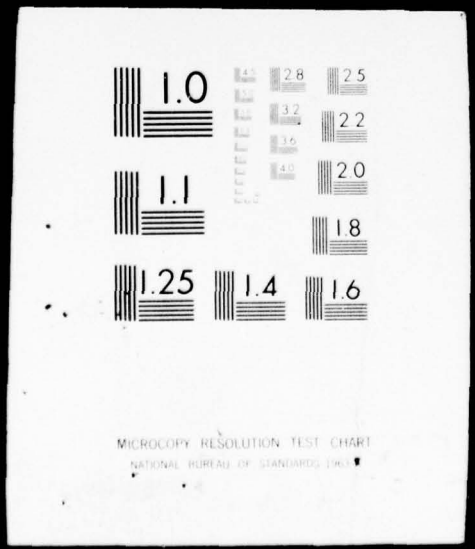

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A SURVEY OF INDUSTRIAL
RESEARCH AND DEVELOPMENT
BUDGETING, EFFORT SELECTION
AND EVALUATION

by

Howard C. Fish
and
Joseph W. Wilson

September 1976

Thesis Advisors J. A. Jolly
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A study was made of procedures used by industry for allocating research and development investments. Areas of inquiry included levels and trends of R&D effort criteria upon which to base budget decisions, personnel selection criteria, apportionment between basic and applied research and development, lead time to results, extension funding criteria, and worth evaluation. CONT.

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Results show a wide range of criteria in use, with principal differences between industries and between companies of different sizes.

Recommendations are made for use of the study results, and for further study and eventual development of a comprehensive decision model.

A Survey of Industrial Research and Development Budgeting, Effort Selection and Evaluation

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ABSTRACT

A study was made of procedures used by industry for allocating research and development investments. Areas of inquiry included levels and trends of R&D effort criteria upon which to base budget decisions, personnel selection criteria, apportionment between basic and applied research and development, lead time to results, extension funding criteria, and worth evaluation.

Results show a wide range of criteria in use, with principal differences between industries and between companies of different sizes.

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I. INTRODUCTION

Within recent history, the United States has enjoyed a continually growing Gross National Product (GNP, the total value of all goods and services produced in a year). However, total research and development (R&D) in the United States decreased steadily over the ten year period ending in 1974 from approximately 3.0 percent to approximately 2.3 percent or $32 billion of the total GNP of $1,396.7 billion. This decrease was shown both by changes in the percent of total GNP dollars spent for R&D, and by the decline of the percentage of population of scientists and engineers working in R&D in the United States [National Science Foundation, 1975].

From Fiscal Year 1966 until the Fiscal Year 1977 budget, the research and development funding within the Department of Defense, and correspondingly within the Department of the Navy, has decreased in terms of buying power as a result of decreasing annual congressional budget authorizations. The decreasing trend in R&D has been accompanied by directed reductions in military and civilian manpower. The share of manpower reductions which the "R&D community" has had to accept has reduced the capacity for effort accomplishment. These effects have been reflected in increasing difficulty of justifying budget, and selecting individual projects or technology areas to be supported. A study which might contribute to development of improved or additional useful judgement and decision criteria was believed to be timely and potentially beneficial.

Due to the prominence of the buying power of the Department of Defense, its declining trend in research and development has been thought likely

to be the most significant factor affecting the overall national trend. As a prominent counter-effect, however, total expenditures for industrial research and development more than doubled from 1960 to 1974 to more than $22 billion in 1974. Eighty percent of all industrial R&D funds were spent by 100 companies engaged in five industries. Those companies spent one-half of the R&D funds for improving existing products, 35 percent for developing new products, and 15 percent for developing new processes [National Science Foundation, 1975]. Accordingly, successful, profit-motivated industry was considered as a proper area to seek decision criteria which may have aided in the success and growth of industrial R&D.

Different scurces vary in their predictions for the future trends in research and development.

> R&D spending has bottomed out and will turn upward in this calendar year. Many factors, including the molasses-fast decisiveness of Congress will hold off any rapid gains, but gains will come slowly at first, then with increasing speed.
>
> We see a $34 billion year in the research and development industry. It's not a big gain over last year's figure, but it is a gain, and that's a start in the right direction [Jones, 1976]."
>
> "Continued inflation in 1976 may cause continued economic weakness, Battelle comments. Nevertheless, in terms of current dollars, R&D activity seems to have returned to the high rate of growth that prevailed before 1968.
>
> The proportionate composition of both funding and performance of R&D will change little, Battelle says . . . [Chemical and Engineering News, 5 January 1976]."

The proposed Federal funded R&D budget for Fiscal Year 1977 is $23.5 billion, up about ten percent over Fiscal Year 1976. This increase will give a solid effort gain providing the estimated inflation rate of 6.5 percent is not exceeded [Chemical and Engineering News, 26 January 1976].

In view of the foregoing predictions, the timeliness of a study of expenditures for R&D in industry was considered appropriate.

A. THE PROBLEM

The allocation of limited funding and manpower to nationally prominent research and development efforts has become a highly visible, politically sensitive procedure. Within the Navy, development of adequate justification to satisfy the myriad of decision review echelons, often has included a field or laboratory commander, Navy Headquarters, Department of Defense reviewers and Congressional committees. This has created a detailed and extensive major task for the office supporting the project. Once justified, the political prominence of a project then virtually assures availability of supporting resources. Many other important supporting types of R&D, equally necessary to overall progress, never reach the political prominence required to get the financial support needed to do the task correctly. Historically, within this latter group has been general support funding for the Navy "Research and Development Laboratories" under the support of the Chief of Naval Material, and the several "Development, Test and Evaluation" facilities of the various Systems Commands and equivalent echelons.

Development and maintenance of "centers of excellence", generalized technology areas, unique test and evaluation capabilities and facilities, and support of academic, industrial, and analogous independent research and development endeavors have been difficult to support.

The Committee on Federal Laboratories [1973], in a study made for the Federal Council for Science and Technology, attempted to formulate a method to measure the performance of Federal research and development laboratories. It was recognized in that study that some peer criticism, periodic project reviews, time and cost studies, benefit analyses, and other rough measures of the quality of effort aided management in

assessing the performance of R&D laboratories in many cases. However, the general conclusion was that "no general performance measure for Federal R&D can be recommended at this time."

B. POSSIBLE BENEFITS TO BE GAINED FROM ALLOCATION CRITERIA

Realistic, relatively objective and non-political proposed evaluation criteria for R&D should simplify and expedite the budget allocation procedure and lead to more productive research and development.

Improved understanding of the interrelationships of resources such as manpower and key equipment which are becoming progressively costly and scarce should encourage more effective distribution, sharing or allocation of such resources.

Quantifiable decision factors could be discovered and developed which would replace the subjectivity of peer evaluation as comparative judgement tools for allocation decisions.

C. OBJECTIVE

The objective of this study is to determine industrial research and development resource budgeting, allocation, selection and evaluation procedures for possible application within the Department of the Navy.

D. SCOPE OF THIS THESIS

This thesis surveys the characteristics of various research and development decision policies and criteria as used by industry. Characteristics examined included budget allocation level, budget trend,

most important project selection criteria, personnel and facility assignment criteria, research and development worth evaluation, and other factors and interrelationships.

This thesis was limited to study of major industrial organizations as defined in the discussion of the determination of survey frame. It was recognized that an analogous survey of other categories of research and development performing organizations such as academic institutions, Federal laboratories, and non-profit (or not-for-profit) laboratories or corporations probably would be required to develop a comprehensive decision model for Navy or other government applications. Observations or recommendations developed from this effort were limited accordingly.

E. HYPOTHESES

The approach to identifying industry research and development decision policies required adoption of some basic hypotheses as follows:

1. The trend of R&D effort levels in general is increasing at a net of ten percent of industrial corporations.
2. More than fifty percent of industry R&D efforts funding is based on a percentage of some financial index of the corporation concerned.
3. For two-thirds of sponsoring companies, less than five percent of basic research efforts yield financially profitable results within five years.
4. For two-thirds of performing companies, the majority of research efforts yielding results warranting follow-on development of new products, did so within four years of initiation.
5. Availability/evaluation of technological expertise is the major factor is selection of the activity or individual to pursue the research and development effort in more than 70 percent of specific efforts.
6. Financially quantifiable benefit of R&D effort is the most important factor in sixty percent of industrial evaluations.

Hypothesis 1 is an attempt to find if there is any correlation between the increase in the R&D national budgetary level predicted by most literature, and the industry observed trend. The remainder of the hypotheses developed, hypotheses 2, 3, 4, 5 and 6, are considered fundamental and potentially useful to Navy decision model development.

II. METHODOLOGY

The survey methodology was designed to encompass the following phases:

Phase I. Personal Interivews

Phase II. Literature Search
1. Search Technique.
2. Literature Review.

Phase III. Development of a Survey Instrument
1. Determination of Topics.
2. Design of the Questionnaire.
3. Determination of Frame.
4. Administration of the Instrument.

A. PERSONAL INTERVIEWS

Recognition of the need and possible benefits of the survey, or a sequence of surveys as initiated by this effort, resulted from the presentation of a Navy R&D manager guest lecturer. Discussion with the lecturer, subsequent lecturers having other government or industry R&D management experience and responsibility, and the authors' experience emphasized the potential utility of a viable non-specific R&D effort decision or justification model.

Additional interviews were conducted with selected R&D managers at Naval Systems Command office levels.

B. LITERATURE SEARCH

1. Search Technique

An initial literature search was conducted using the National Technical Information System and the Defense Logistics Studies Information Exchange data bank systems. Concurrent library research of periodicals and books was pursued at public, university, and defense establishment libraries. The services of a commercial information research organization were engaged. After consultation, a repeat search of the National Technical Information System was conducted. This search was augmented by searches of the Engineering Index and the Inform data banks. These searches were conducted using the key word combinations and groupings of Research/Development (both words in any combination), Industrial (with) Research, Economic Budget, Cost, Civilian Investment, Cost (with) Analysis, and Research and Development, and the time frame of 1970 and subsequent publications. Abstracts thus obtained, cross-referencing of articles, references and bibliographies of the items acquired, and the facilities of the Library of Congress, the National Science Foundation and additional search of university libraries yielded a wide spectrum of related publications. The more pertinent of these publications are referenced as applicable, and enumerated in the List of References and Bibliography.

2. Literature Review

During the literature review, the interrelationships of various facets of research and development were clearly evident as expected. Thus, it was infeasible to separate literature as exclusively relative

to any particular hypothesis. Facets and key concepts of articles and publications were synopsized to aid correlation, and cataloging was limited to use as a ready reference system and for bibliography development.

Literature relating to the characteristics judged most adaptable to possible Navy use formed the basis for developing the hypotheses to be tested. This literature further contributed to the concurrent development of the test instrument.

C. DEVELOPMENT OF A SURVEY INSTRUMENT

1. Determination of Topics

The literature review provided the authors with a good understanding of the problems of selecting R&D projects and evaluating the results of R&D effort. The literature also generated a desire for information on more recent attitudes of high level executives toward the policies and the extent of R&D effort at their companies. In order to obtain the needed information, a questionnaire containing twenty-seven questions was designed and entitled "Survey of Research and Development Management" (Appendix B). The questionnaire was directed toward high level management personnel that were expected to have a good understanding of the R&D policies and procedures of their companies.

The topic areas of investigation were: (1) R&D effort level, (2) R&D effort trends, (3) R&D budget formulation, (4) R&D budget breakdown, (5) expectation of results from R&D, (6) R&D funding sources, (7) R&D project selection criteria, (8) staffing R&D sections, and (9) R&D evaluation.

2. Design of the Questionnaire

The questionnaire was divided into three sections. Section One, Background Information, concerned the demographic aspects of the respondent and the respondent's company. Section Two, Budgetary Considerations, related to the company's policies and procedures on R&D budget allocation, funding, and expected results. Section Three, General Management, covered R&D staffing, program selection, effort implementation, effort trends, and program evaluation.

3. Determination of Frame

A survey of major business enterprises was made to attempt to discover management criteria which might be useful in developing a management model for Navy or other Federal systems. The major businesses group was selected in order that any techniques discovered would be useful to a business comparable in size to major segments or laboratories of the Navy. Forbes' 500s [1976] and Fortune 500 [1976] listings of American business and industry were used as a starting base for defining the survey frame.

The Forbes' 500s analysis tabulated four business measurement factors, namely assets, sales, common market value and net profit. Most organizations listed among the top 500s were in more than one category. In consideration of the second hypothesis, which anticipated that most industries planned research and development budgeting as a percentage of some financial index, the most probable business measurement factor was a percent of sales volume. The sales 500 listing was judged most applicable for the desired survey. The Forbes' 500 sales listing was then expanded by including additional companies from the Fortune 500 tabulation to compile the final survey mailing list.

4. Administration of the Instrument

All outgoing mailings were addressed to the "Director of Research/Development." The cover letter forwarding the questionnaire attempted to explain the nature and goal of the survey, to sincerely acknowledge the importance of contributions which the leaders of American industry and business would provide, and to assure all potential respondents that the protection of anonymity would be provided in the data analysis.

III. ANALYSIS OF RESULTS

During the literature review, definitions of basic and applied research seemed not to differ significantly among the Department of Defense, the National Science Foundation, academic institutions and industry. Some government or industrial activities are, however, on occasion organizationally segmented into development, testing, evaluation, laboratory, design and other categories. Accordingly, to aid in consistency in response and interpretation of this questionnaire, the following definitions were provided.

> BASIC RESEARCH includes original investigations for the advancement of scientific knowledge that do not have specific commercial objectives, although such investigations may be in the field of present or potential interest of the reporting company.
>
> APPLIED RESEARCH includes investigations directed to the discovery of new scientific knowledge that has specific commercial objectives with respect to products or processes . . . , applied research differs from . . . basic research chiefly in terms of the objectives of the reporting company.
>
> DEVELOPMENT includes technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes. Development does not include routine technical services or other activities excluded from research and development.

A. GENERAL CHARACTERISTICS

1. Responses to Instrument

The survey instrument was mailed to 597 commercial organizations. Twelve responses were returned incomplete. Some of the reasons for incomplete forms were: (1) conflict with company policy as preventing information release, (2) R&D was conducted by subsidiary company, therefore desired information was not available, and (3) the company does not conduct research or development. Completed questionnaires, with minimal if any missing data, were received from 147 respondents; these form the basis for the data analysis. Twenty-six percent of the companies responded, with ninety-three percent of responses analyzable.

2. Analytical Techniques

Upon receipt, each completed questionnaire was reviewed, response to Question 4 of Section One which gave the position title of the respondent was coded, missing data points were noted, voluntary comments were tabulated, and data was prepared for computer analysis procedures. Computer analysis was conducted utilizing the Frequencies with Statistics, Crosstabulations, Histograms, Scattergrams and Non-Parametric Correlation subroutines of the Statistical Package for the Social Sciences [Nie, 1975].

Possible answers offered for selection for a specific question were progressive in value, but not necessarily uniform in value distribution. For example, Question 1 of Section One asked for the number of laboratories maintained by the company, giving a selection of answers as 1, 2 to 5, 6 to 10, 11 to 15, or over 15 laboratories. While these

responses progressively increased in size or extent, the amount of change from one possible answer to the next was not always uniform; thus, in statistical terms, the response ranking was ordinal (progressive), but not interval (in equal sized intervals). Kendall's or Spearman's correlation formulae were therefore appropriate for comparing data of this type. Application of these tests determined the relationship of factors (variables) tested. The magnitude of the value computed indicated the acceptance (similarity) or rejection (difference) of the related correlation or hypothesis. The Kendall's or Spearman's significance number (0.05, 0.01 or higher level of statistical significance, which signifies 95 percent, 99 percent or higher confidence level respectively) indicates the probability that the relationship thus determined is not accidental.

Coded answers to questionnaires were analyzed using the computer programs referenced above. The Frequencies subroutine was used to investigate the number of times a specific answer was indicated for each question. The Histograms subroutine was used to plot the distribution of these answers. The computed Statistics analysis indicated statistical characteristics and percentages of answers as related to a particular question. Crosstabulations and Scattergrams analyses were used to investigate possible correlations between specific factors (variables) which might yield clues to the manner in which industry relates these factors. The results of the Non-Parametric Correlation computer program (Kendall's Tau and Spearman's Rho) were used to determine the degree to which the relationships were reliable or accidental.

The most illustrative computer output results were reproduced and included in the appropriate Appendix of this thesis.

Analysis of responses was organized in the following discussion in relation to specific questions, groups of questions, segments of the questionnaire, and as applicable to a specific hypothesis, in the manner considered best explanatory.

B. SECTION ONE - BACKGROUND INFORMATION

This group of questions was included to provide background information on the company of the respondent and to provide credibility to the information obtained from the survey.

1. Number of Laboratories

Question 1. How many research and/or development laboratories or facilities does your company operate?
(1) one, (2) 2 to 5, (3) 6 to 10, (4) 11 to 15, (5) over 15

The U. S. Navy has many R&D Laboratories over the United States; therefore, it was believed important to obtain information concerning R&D management from some industrial companies with multiple facilities that possibly would be comparable to U. S. Navy R&D operations.

Approximately 42 percent of the companies responding had from two to five laboratories; 28 percent had only one. Eighty-six percent of all organizations had from one to ten laboratories. Only nine percent of the organizations, all with 10,000 or more employees, had more than 15 R&D facilities.

2. Company Size

Question 2. Your company size as indicated by total number of employees:

(1) Less than 5,000	(4) 20,000 to 39,999
(2) 5,000 to 9,999	(5) 40,000 to 79,999
(3) 10,000 to 19,999	(6) 80,000 or more

Companies with 10,000 or more employees consumed over four-fifths of U. S. industrial R&D funds in 1971. One hundred of these companies accounted for three-fourths of all industrial R&D for that year [Horwitch and Prahalad, 1976]. The size of the respondent's company was considered important, because the larger companies probably more closely approximate the U. S. Navy.

The number and percentage distribution of various size responding companies, as measured by their respective number of employees, is shown in Table 1.

TABLE 1

DISTRIBUTION OF COMPANIES BY SIZE

Number of Employees	Number of Responding Companies	Percentage of Responding Companies
under 5,000	9	6.1
5,000 to 9,999	25	17.0
10,000 to 19,999	54	36.7
20,000 to 39,999	29	19.7
40,000 to 79,999	20	13.6
over 80,000	10	6.8

All possible answers to Questions 1 and 2 received response, thus showing that all types of major industry were represented.

There was a moderate positive correlation between the company size and the number of laboratories, as signified by a Kendall Tau of 0.24 with a significance of .001. This confirms the expectation that, in general, a large number of facilities would be operated by a relatively large company.

3. Industry Classification

Question 3. As a very general industry classification, the greater portion of your company's activities would be:
(1) Durable goods industry
(2) Non-durable goods industry
(3) Services industry
(4) Diversified industry

This question was prompted by a study by Gellein and Newman [1973] on the accounting practices of several companies regarding costs incurred in industrial funded R&D. This study indicated approximately 47 percent of the responding companies were engaged in durable goods industries, 37 percent in non-durable goods, and 16 percent were diversified. Services industries were not separately considered in this study.

Durable goods were considered as items produced with an expected normal life of more than a year, such as machinery, automobiles and buildings. Non-durable goods were considered as being consumed or expended within a relatively short period. Services referred to industries providing consumers with benefits other than physical goods, for example, airlines, utility companies and insurance companies. The diversified companies were engaged in some combination of the above industries.

It was considered to be important to include the category of "services industry," because several services organizations are included in the Forbes' 500s and the Fortune 500 lists. Also, several Navy facilities' missions include consulting, design support, inspection, test and evaluation and other functions which might logically be classed as services.

The categories of activities or products of the responding companies were widely distributed with 33 percent of the companies producing durable goods, 31 percent producing non-durable goods, 23 percent

diversified in products and interests, and only 13 percent engaged in service oriented activities.

Nineteen of the twenty companies with more than ten laboratories were engaged in the production of durable goods or diversified products. No service oriented company had more than five facilities, and 71 percent of them had only one laboratory. The services organizations were concentrated in the middle sized group.

4. Respondent Corporate Level

Question 4. (Optional) Please specify your official title in the company organization. _____

It was believed that the information obtained by the survey would have greater credibility if provided by a high level executive of the company who probably would have an optimal understanding of overall corporate policy.

Four categories were defined and coded. Category one included presidents and vice-presidents, category two was defined as a major segment director or division manager, category three was related to a department or section manager, and category four was assigned to the respondents not identifying their respective title. Thirty-nine percent of the respondents who indicated their title were either presidents or vice-presidents, 38 percent were segment directors, 12 percent were department or section managers, and only 11 percent remained anonymous. The very high percentages in the first two categories indicated a high degree of executive interest and responsiveness. This factor was considered to infer substantial validity of the policy indications shown by the remaining data.

C. SECTION TWO - BUDGETARY CONSIDERATIONS

This group of questions was designed to yield information on the recent industry R&D effort trend, the basis on which companies decide how much to spend on R&D, how the R&D effort is divided, lead times to reach R&D profitability, and what portion of R&D effort is company financed.

1. R&D Effort Trend

Question 1. How do you perceive your company's R & D effort over the past five years?
(1) No significant change
(2) Increased significantly
(3) Decreased significantly
(4) Suspended R & D efforts

Laserson and Sperling [1972] found from a survey of a large number of industrial research organizations that 47 percent of responding companies had reduced their R&D effort during the period 1968 to 1971.

An opinion poll by Industrial Research [January 1975] summarized the question "Is your company holding its R&D expenditures about even with those for 1970-73?" The results, when grouped, showed 30 percent about equal, 32 percent increasing, 28 percent decreasing, one percent dropped R&D, and eight percent other. This article further stated that "In 1973, 81% of the respondents felt that the amount of R&D in their company would increase, while in 1974, only 62% felt that their expenditures would remain equal or increase slightly."

The Federal budget for Fiscal Year 1977 submitted to Congress contained an eleven percent increase over Fiscal Year 1976 for Federal funded R&D. This increase of $2.5 billion brings the total Federal R&D budget to $22.6 billion [Chemical and Engineering News, 2 February 1976].

The intent of this question was to learn the overall trend

experienced by major industries (as recognized by Forbes and Fortune) in research and development effort, in terms of combined internally and externally funded effort, for comparison with the referenced studies. A general R&D growth pattern over the last five years was indicated based on a 46 percent response of no change of effort together with a 45 percent response which showed a marked increase. Only nine percent of respondents recorded a marked decrease, and none suspended research and development during this period. The first hypothesis of this thesis, based on recent literature, predicted an increasing trend at a net of ten percent of industrial corporations. "Net" was intended to mean the overall effect; that is, the percentage increasing minus the percentage decreasing. This survey strongly supported acceptance of the first hypothesis with a net of 36 percent indicating an increasing trend.

Further correlation with answers to Section One questions revealed that of the 30 companies with more than 40,000 employees, 17 had stable R&D efforts, 11 had marked increases, and only two had marked decreases. The above data inferred a much more optimistic future for growth of research and development effort than was reported in the studies of Laserson and Sperling, and the opinion poll of Industrial Research.

2. Percentage of Operating Budget

Question 2. What percentage of your total operating budget does your R & D effort constitute?

(1) Less than 2%
(2) 2 to 4%
(3) 5 to 7%
(4) 8 to 10%
(5) Greater than 10%

The R&D expenditures of a company, as a percentage of its operating budget, provides a measure of the "R&D intensity" level. Companies

are usually considered to be in the high intensity category if their R&D effort is more than two percent of the operating budget or of net sales [National Science Foundation, 1975].

Over 62 percent of the companies responding indicated that less than two percent of their total operating budget was devoted to research and development. By the National Science Foundation criterion, these were classifiable as not R&D intensive. The moderately intensive group of from two percent to four percent included 26 percent of the respondents.

Only five companies indicated greater than ten percent commitment; the two largest of these companies classified themselves as durable goods industry, two others as diversified, and the fifth as non-durable goods industry. The highly intensive research and development effort was not restricted to any specific category or size of industry.

3. Financial Index and Percentage of Index

Question 3. Annual R & D budgetary level is planned as:
(1) A percentage of net sales
(2) A percentage of net profit before taxes
(3) A percentage of net profit after taxes
(4) A percentage of total operating budget
(5) Specified other corporate financial index_____
(6) Limited to active contracts; i.e., no in-house development
(7) Not related to a financial index or factor of corporate operations. General basis is_____

Question 4. Total R & D budget is limited to:
(1) Not to exceed 2% of the above indicated financial index
(2) Not to exceed 4% of the above indicated financial index
(3) Not to exceed 7% of the above indicated financial index
(4) Not to exceed 10% of the above indicated financial index
(5) Other_____

The National Science Foundation [1975] definition of R&D

intensive effort as a percentage of operating budget or sales was reflected in these questions.

The second hypothesis proposed that more than fifty percent of industry R&D efforts funding was based on some corporation financial index. Questions 3 and 4 attempted to prove the hypothesis, and to determine the extent of the budgeting based on the respective indexes.

The first analysis of coded answers to Question 3 indicated that 61 percent of answering companies do not budget R&D based on any financial index. An additional four percent used active contracts as a basis for budgeting. Therefore, the second hypothesis was rejected. The null hypothesis, that less than fifty percent of industry R&D efforts funding is based on a percentage of some corporate financial index, was accepted.

Of the 35 percent that did specify a financial index as a base for budgeting, nearly two-thirds (30 companies) used a percentage of sales.

Sixty-one percent of the respondents also indicated, in Question 4, that they used a basis other than a percentage for funds allocation. Nearly 13 percent did not answer this question.

The last answer available for selection in each question was intended to allow respondents to indicate some financial index or characteristic not previously discussed in the literature or otherwise considered. In this respect, all but one of the companies specifying "not related" to Question 3, also answered "other" or did not answer Question 4. However, most did offer clarifying comments as tabulated in Appendix A.

Of the 88 responses marked "not related to any index," 35 of

these, or 24 percent, indicated the R&D budgetary level was determined by the company management's assessment of needs and requirements. Seven respondents indicated R&D budget was planned as opportunities arose, and six indicated the value of a project was the determining factor. Responses tabulated in Table 2 show that the most frequently indicated answer was "need."

TABLE 2

INDUSTRIAL BASIS FOR R&D BUDGET PLANNING

Basis or Index	Company Responses Received	
	Number of Responses	Percentage of Responses
Perceived Need	35	24
Net Sales	30	21
Total Budget	12	8
Opportunities	7	5
Value of Projects	6	4
Outside Financed	6	4
Profit After Taxes	3	2
Other Index	3	2
Profit Before Taxes	2	1
Miscellaneous	40	28

NOTE: Percentages are rounded to the nearest whole number.

The respondents indicating "other" as an R&D budget limit, specified various criteria for their maximum R&D budget level. The most frequent comment, approximately 20 percent, stated that their company had no specified limit on the R&D budget amount. Of the 90 responses that indicated "other" budget limit, 34 did not volunteer any criteria for

setting their R&D budget limit, thereby restricting analysis. The specific comments on this question are also included in Appendix A.

4. R&D Effort Distribution

Question 5. What percentage of R & D effort is directed toward basic research?
(1) Less than 5% (3) 10 to 14% (5) 20% or greater
(2) 5 to 9% (4) 15 to 19%

Question 6. What percentage of R & D effort is directed toward applied research?
(1) Less than 10% (3) 20 to 29% (5) 40 to 49%
(2) 10 to 19% (4) 30 to 39% (6) 50% or greater

Question 7. What percentage of R & D effort is directed toward development projects?
(1) Less than 20% (3) 40 to 59% (5) 80 to 100%
(2) 20 to 39% (4) 60 to 79%

These questions were designed to give information on the relative emphasis on industrial basic research, applied research, and development to compare with the literature findings. In an attempt to achieve uniformity in answers and interpretation, National Science Foundation definitions of basic research, applied research, and development were included in the questionnaire instructions and were repeated in part D above.

The breakdown of overall resource allocations to research and development as reported in 1974 was 13 percent for basic research, 23 percent for applied research, and 64 percent for development. This included efforts funded by Government, industry, educational institutions and others. The industrial funding allocation was three percent for basic, 18 percent for applied, and 79 percent for development [National Science Foundation, 1975].

The Federal Government share of the basic research effort has increased from 60 percent to 70 percent over the time period from 1960

to 1974. The Universities have increased the funds expended on basic research from six percent to 11 percent of the total research budget over the period from 1960 to 1974, while industrial funding has decreased for basic research from 28 percent to 11 percent over the same period. The trend by industry to shift their effort toward applied research and development "has been so great that, in some cases, there has been a danger of its squeezing out disinterested research, which would have been as absurd as killing the goose that lays the golden eggs [Auger, 1975]."

As much as 90 percent of an industrial company's development effort is engineering related to new products and the remainder is research according to the vice-president of engineering of a large industrial company [Commerce Today, 1974].

In contrast to some of the above literature indications, this survey seemed to indicate more emphasis on applied research, and a slight decrease in development effort. The order of importance was the same as previously reported for industry, however. Of the companies responding, 80 percent allocated less than five percent of their R&D budget to basic research. Over 50 percent denoted that 20 percent of more of the R&D budget was allocated to applied research, and 60 percent directed 60 percent or more to development. The relative efforts by category of R&D, as indicated by survey responses, are shown in the Computer Output for basic research, applied research, and development.

Table 3 relates these breakdown ranges and shows the shift in the nature of R&D effort as indicated by the responding companies.

TABLE 3

RESEARCH AND DEVELOPMENT EFFORT EMPHASIS BY CATEGORY

Percentage of Effort	Percentage of Responding Companies		
	Basic Research	Applied Research	Development
Under 5	80.1	19.7	4.8
5 to 9	6.8		
10 to 14	4.8	24.5	
15 to 19	4.8		
20 to 29	* 3.4	16.3	7.5
30 to 39		10.2	
40 to 49		12.2	27.2
50 to 59		** 17.0	
60 to 79			25.2
80 to 100			35.4

* 20 percent or greater.
** 50 percent or greater.

5. R&D Lead Time

Question 8. What percentage of basic research projects yield financially profitable results within five years of initial research?
(1) Less than 2%
(2) 2 to 4%
(3) 5 to 7%
(4) 8 to 10%
(5) Greater than 10%

Question 9. Of those basic and applied research efforts that lead to a decision to go ahead with development, the majority of them involve a time period from initiation to development decision of:
(1) Less than 2 years
(2) 2 to 4 years
(3) 5 to 10 years
(4) 11 to 20 years
(5) More than 20 years

Question 10. Of these R & D projects that lead to useful or profitable products, the majority of them involve a time period from initiation to profit of:
(1) Less than 2 years
(2) 2 to 4 years
(3) 5 to 10 years
(4) 11 to 20 years
(5) More than 20 years

It is very difficult to determine an average for the percentage of projects that became successful out of all the projects that were begun in the R&D community. It has been estimated that among products that have emerged from R&D departments as technical successes, only one in three ultimately develops into a commercial success. Other estimates state that only one of twenty-five products that are test marketed become successful [Roman, 1968].

"The average period elapsing between the time when a new process is discovered by applied research and the time when the substance or apparatus produced by the process is placed on the market has been greatly reduced since the beginning of the century - from several years to a few months in some cases [Auger, 1975]."

The anticipated return on R&D takes place beginning three to ten years after project initiation into the development phase. It is not unusual for twenty years to elapse, from the basic research phase, before commercialization of a product begins [Laserson and Sperling, 1972].

The cost of implementing an invention or discovery can create a long delay in gathering needed funds. The capital needed to apply an invention to a useful purpose averages about five times the cost of the research and development that made the invention possible [The Economist, 1975].

It was evident that very few R&D projects which were begun ever became successful, and that those that were successful had long lead times. The above questions, as a group, attempted to determine the current success ratio and relative lead time of the successful projects or efforts.

Of the companies responding, 68 percent indicated that less than

two percent of their basic R&D projects became profitable within five years after beginning the research. An additional three percent of the companies indicated that from two to four percent of their basic research was profitable within this time frame. The third hypothesis proposed that for two-thirds of sponsoring companies, less than five percent of basic research efforts yield financially profitable results within five years. This total of 71 percent with less than five percent profitability from basic research within five years was considered as validating and accepting the third hypothesis. By contrast, 13 percent indicated that over ten percent of their basic R&D projects yielded a profit within five years.

In response to Question 9, the largest group, 44.4 percent, indicated that the decision to go into a development program for a project occurred from two to four years after initial research began. In addition, 21.8 percent indicated less than two years to a development decision. The fourth hypothesis predicted that, for two-thirds of the performing companies, the majority of research efforts yielding results warranting follow-on development of new products did so within four years of initiation. When combined, these two groups represent 66.2 percent of the total respondents; therefore, the fourth hypothesis is marginally rejected. The null hypothesis was accepted, that for one-third of performing companies, the majority of research efforts yielding results and warranting follow-on development of new products required more than four years from initiation. The longer period of five to ten years was indicated by 31.0 percent of the companies, and the period 11 to 20 years by an additional nearly three percent.

In response to Question 10, nearly 50 percent of the respondents

stated that the R&D projects that did become profitable, did so within five to ten years after initiation. Only 12 percent indicated lead times less than two years, and 32 percent realized profits between two and four years subsequent to initial research. Recognizing that a decision to go ahead with development of new products (Question 9) does not automatically mean profitability, Question 10 attempted to determine any relationship between the time to "go-ahead" and the time to profitability. The computed Kendall's Tau correlation factor related to these two variables was 0.43 with a significance of 0.001, which inferred a very high confidence in a strong correlation. This correlation means that the trend of the percentages indicates that as the time required from project initiation to a development go-ahead decision became longer, so did the support time requirement to reach a profitability situation. However, the added effect which can be inferred by this comparison of shifts of percentages was that any increase in development time caused a substantially greater increase in time to reach profitability.

Table 4 shows this relation between these two factors.

TABLE 4

LEAD TIMES FROM INITIATION OF R&D EFFORTS

Years	Percentage of Respondents Indicating Lead Time	
	To Development Go-Ahead Decision	To Profitability
Under 2	21.8	11.7
2 to 4	44.4	32.4
5 to 10	31.0	49.7
11 to 20	2.8	6.2

Comparison of answers to these questions also inferred that if Question 8 had allowed a variance of time, or particularly a longer time, the percentage of successful efforts reported would probably have been greater. Since several responding companies indicated, as tabulated in Appendix A, that they did not conduct basic research, it was not surprising that many more "missing" data points were coded for Question 8 than for Questions 9 and 10.

Considering the three questions as a group, data were interpreted as showing that a substantial proportion of industry willingly supported R&D efforts over sustained time periods in the expectation of eventual, but not guaranteed, payoffs.

6. Percentage of R&D Internally Funded

Question 11. What percentage of your basic research effort is internally funded?

(1) Less than 20%
(2) 20 to 39%
(3) 40 to 59%
(4) 60 to 79%
(5) 80 to 100%

Question 12. What percentage of your applied research effort is internally funded?

(1) Less than 20%
(2) 20 to 39%
(3) 40 to 59%
(4) 60 to 79%
(5) 80 to 100%

Question 13. What percentage of your development effort is internally funded?

(1) Less than 20%
(2) 20 to 39%
(3) 40 to 59%
(4) 60 to 79%
(5) 80 to 100%

The literature survey in general indicated that a significant portion of industrial R&D was funded by other than the performing companies.

Questions 11, 12, and 13 were designed to determine the level of internal funding, and also to discover any strong tendency to seek

outside funded effort. It was evident from the data that most of the industrial R&D effort was funded directly by the performing companies. Eighty-three percent of respondents conducting basic research internally funded more than 80 percent, while only 12 percent funded less than 20 percent. A larger percentage, 84 percent, funded more than 80 percent of their applied research, and 88 percent funded over 80 percent of their development effort. A positive correlation was found between the company size and the companies that internally fund their basic research effort, as indicated by a Kendall Tau of 0.23 with a significance of 0.001. This was interpreted to indicate that the larger the company, the more likely it is to conduct its own research.

The survey responses to these questions are summarized in Table 5.

TABLE 5

PERCENTAGE OF R&D EFFORT INTERNALLY FUNDED

Percentage of R&D Funded by Respondent	Percentage of Responding Companies		
	Basic Research	Applied Research	Development
Less than 20%	11.8	5.6	4.1
20 to 39%	1.6	0.7	2.1
40 to 59%	2.4	5.6	2.1
60 to 79%	1.6	4.2	4.1
80 to 100%	82.7	84.0	87.6

D. SECTION THREE - GENERAL MANAGEMENT

This section of the test instrument was designed to provide information on the management of R&D in the industrial sector for possible clues to a system that would improve Navy management effectiveness and efficiency.

The federal government has been criticized many times for the management of resources under government control. One of the criticisms was: "federal-funded civilian research and development is not sufficient to bring about technological change in the private sector to any significant extent [Government Executive, June 1976]." This article reviewed a report by Arthur D. Little, Inc. which indicated that the federal government was doing very little to "push" and "distribute" technological innovations to the industrial community where the major benefits could be realized. According to this report, for technological innovations to be implemented, convergence of six elements was required. The elements proposed were (1) knowledge generated through R&D, (2) user need, (3) an advocate or champion, (4) availability of resources, (5) favorable risk factors, and (6) favorable timing. It was suggested that the federal government could supply some of the missing elements, such as resources needed and favorable risk factors to expedite the innovations.

1. Primary Task Assignment

Question 1. Selection and assignment of a specific R & D task to an organizational group or individual is based primarily on:

(1) Availability of demonstrated project management expertise
(2) Availability of technological expertise in-house
(3) Formation of a new group incorporating both management and technological expertise (includes organizational reassignment)
(4) Availability of support personnel

(5) If capability not existant in-house, contract to best qualified management sub-contractor
(6) If capability not existant in-house, contract to best qualified technologically qualified sub-contractor
(7) Available in-house personnel with best background adaptable with minimum training
(8) Other

Selection and assignment of a specific R&D task to a group or individual was based primarily on the availability of in-house technological expertise, according to 47 percent of the respondents. Twenty-five percent of the companies assigned R&D tasks by the availability of personnel with good background and adaptability to training for the specific task. It was considered that background and adaptability for training reasonably represent an available technological capability needing only a relatively minor upgrading. Accordingly, it was believed that these two factors were sufficiently related to combine them for analysis. Seventy-two percent of the companies (the combination) assigned tasks on the basis of available in-house personnel either possessing specific required technological background, or adaptability to be trained to perform the specific tasks.

The fifth hypothesis contends that availability/evaluation of technological expertise is the major factor in selection of the activity or individual to pursue the research and development effort in more than 70 percent of specific efforts. Accordingly, the above data were considered as verifying acceptance of this hypothesis. The sixth answer offered for selection asked about choice of a sub-contractor on the basis of technological qualification. An additional six percent of respondents indicated this choice; therefore, the fifth hypothesis was considered as supported.

2. Project Priority Criterion

Question 2. Which R & D project objective would get highest priority at your company?

(1) Reducing operating costs of processes
(2) Timeliness (with respect to _____)
(3) Improving company's competitive position by providing better products
(4) Probability of success of R & D project
(5) Soundness of technological approach
(6) Estimated cost
(7) Product diversification for company growth
(8) Other (specify) _____

This question was to obtain an evaluation of R&D project selection criteria among industrial companies and to compare the findings with the literature survey results.

It is considered very important by most management personnel to define goals and objectives for the R&D effort within a company. Approximately 94 percent of companies performing a significant amount of R&D have specific objectives, however, only 79 percent have written objectives [Seiler, 1965]. Most of these R&D objectives are formulated to satisfy six basic goals:

"1. To ensure that the corporation will continue to operate in areas of growing business activity.

2. To make the best possible use of the corporation's resources, including scarce raw materials, technical specialties, and management talent.

3. To utilize available markets and develop new ones to the fullest extent possible.

4. To diversify the corporation's activities for maximum stability.

5. To ensure continuing and steadily increasing profits for the corporation.

6. To contribute to the corporation's ability to accept appropriate responsibilities in the social environment in which it operates."

It is believed that more effort should be given to defining more specifically R&D objectives in most companies.

Industrial research projects have the objectives of (1) reducing operating costs, (2) improving the company's competitive position by providing quality products and technical assistance, and (3) developing new investment opportunities for the company and opening additional markets for new or present products [Roman, 1968]. Project selection depends on quantitative and qualitative factors that are very difficult to determine in most cases. Mr. Roman very accurately described the project selection situation in his statement:

> "Everything involved in project selection is relative. It is nigh on impossible to establish a quantitative formula which takes all the subjective factors into consideration. From the many aspects of a project and their varying effects, it is apparent that no set format will answer all management's decision-making needs. Methodology can be employed as a screening process prior to the final decision. A quantitative approach will narrow the possibilities and provide a smaller field of focus, but the capability and intuition of the decision-maker may well be the most critical elements in project selection."

R&D project selection in the government differs from that in private industry primarily because of the different objectives involved. In industry, the need and potential profit are the two most compelling factors affecting project selection, while in government, the driving force is mission accomplishment. These differences in objectives change the relative weights on other factors of project selection, such as project cost, cost savings and personnel requirements.

"The selection of projects upon which to expend resources in any company involves consideration of many factors. Some of these factors are requirement, soundness of technological approach, probability of project success, timeliness of the project, and estimated cost [Das, 1969]." Das performed a study to see if reliable project selection

could be made based on these factors alone, and came to the conclusion that the measures of importance of projects probably have significant association with additional factors not considered in his study.

There are certain criteria that can be used during the R&D planning stage to measure the probable success of a research program. These criteria are normally associated with consideration of (1) goals of the sponsor, monitor, and researchers, (2) competence of the research personnel, (3) value of the program and progress made, (4) the recognition granted by all parties concerned, and (5) specific results [Salkovitz, Armstrong, and Howe, 1970]. Attempts to apply linear programming techniques to the problem of project selection for the allocation of research and development resources appear to have some merit [Freeman and Gear, 1971].

The data of this survey well supports the general objectives of industrial R&D as proposed both by Seiler and by Roman since improving the company's competitive position by providing better products was selected as the primary objective for the R&D effort by 54 percent of the respondents. Seventeen percent of the companies indicated cost reduction as the primary objective, and eight percent indicated company growth.

In addition to the respondents placing importance on cost reduction, other respondents also agreed with the proposals made by Das [1969]; seven percent indicated timeliness, and three percent cited probability of success.

Numerous comments were offered by the eleven percent of the respondents who selected "other" as an answer. These comments, and additional ideas by companies that selected specific offered answers to the question, were tabulated in Appendix A. Several of these comments

indicated that more than one or all of the suggested criteria were used in establishing project priority. As to what might be considered an opposite extreme, some comments indicated government regulations as a determining factor.

3. Budget Commitment Stage

Question 3. At what stage in the budget formulation process is the funding level committed for R & D?
(1) Beginning of the planning phase
(2) When sales estimates are made
(3) When profit estimates are made
(4) At end of budget allocation, providing funds are available
(5) Other (specify)_____

The importance of long range planning of R&D cannot be over emphasized. Many authors feel that R&D planning should be for a minimum of five years and the planning process should follow seven major steps:

"1. Specify as clearly as possible the basic technological objectives which are of primary interest. These may be stated broadly at the beginning but must eventually be broken down into particular areas.

2. Identify the goals toward which the company is working, which ideally are set forth in the corporate and the research objectives.

3. In keeping with the preceding two factors, seriously and imaginatively consider all possible results which may be achieved if the research efforts are successful.

4. Rank the hypothetical capabilities of the research efforts as determined in the preceding step, in terms of their potential contribution to the achievement of specific goals. The ranking should provide insight into the efforts needed to achieve the corporate or the research objectives.

5. Outline the principal technological steps which are required to achieve the hypothetical research results listed in the preceding step. Such an outline should uncover the more significant gaps in existing knowledge.

6. Select the small number of high-value research results, as determined previously, which have reasonably well-specified steps and a minimum number of knowledge gaps. Give these results further examination and consideration for full-scale research efforts.

7. Remain alert to any developments that could significantly change the value ratings used in the preceding steps. When research breakthroughs fill in missing knowledge gaps, the process should be repeated."

The accomplishments of the above steps may prove to be difficult in many cases, however, they are considered necessary for meaningful, realistic planning [Seiler, 1965].

Some of the major difficulties encountered in planning basic research are: (1) feedback is long delayed, (2) the research is not repeated, (3) sometimes the attitudes of those working together on a project are at cross-purposes, (4) attitudes of those involved in research can hinder plans, and (5) research plans can be rendered obsolete by inventions elsewhere [McGlauchin, 1968].

The planning and budgeting of R&D has been recognized almost universally as a very difficult task and broad enough in scope to justify a study by itself. For purposes of this survey, the question was intentionally simplified and attempted only to determine the basic time in the budgeting process when commitment of funds is actually planned or specified to support R&D effort.

Nearly one-half of the responding companies committed funds to R&D effort at the beginning of their budget planning phase. Research and development budgeting, therefore, was a prominent part of the fiscal planning cycle for this group.

Sixteen percent (23 companies) indicated that R&D funding was committed when profit estimates were made. No attempt was made in this questionnaire to learn when profit or sales estimates were made relative

to other parts of the planning cycle.

Ten percent (15 companies) indicated that R&D funding commitment was made when sales estimates were made. Of these 15 companies, only seven were among the group of 30 companies that had indicated planning as a percentage of sales in response to the earlier question.

It appeared that the use of a controlling financial index for R&D budgetary planning factor was not necessarily coordinated with the development of the budgetary plan. This attested both to the complexity of the budgeting process, and the decisions related to R&D funding support.

An additional 11 percent of the respondents committed R&D funding at the end of the budget allocation process provided funds were available, and 13 percent determined R&D funding at other times.

4. Equipment Acquisition Method

Question 4. If you anticipate equipment requirements for R & D effort in addition to current R & D capability, your most common acquisition method is:
(1) Purchase to establish or maintain general research capability
(2) Purchase for specific R & D task
(3) Transfer to R & D upon completion of other usage
(4) Develop in-house as need arises
(5) Other (specify)_____

Some previous surveys or treatises on research and development have recognized the importance of making "the best possible use of the corporation's resources [Seiler, 1965]." No literature was discovered which presented results of inquiries into policy or procedure as practiced to support R&D equipment requirements.

"Successful research and development revolve around the creative, talented scientist. Nothing useful or valuable can be done without the trained, talented, innovative human brain.

But the researcher can be severely limited, and at times prevented from making progress, if his research tools are inadequate [Industrial Research, January 1975]."

Less than two percent of responding companies in this survey transferred equipment within house for R&D uses. This indicated that nearly all companies obtain and commit needed equipment directly for R&D support.

Fifty-two percent of the companies purchased equipment to perform specific R&D tasks. Thirty-five percent purchased equipment to establish or maintain general research capability, seven percent developed their own equipment for R&D, and about four percent obtained R&D support equipment from other sources.

5. Funds Reprogramming Criterion

Question 5. What is the most important criteria of your policy regarding reprogramming of R & D funds?
(1) As new opportunities or ideas are generated
(2) Upon failure of existing R & D projects to materialize useful results/products
(3) Based on periodic review of all ongoing efforts
(4) Observed/predicted major shift of competitor's direction of effort
(5) Other (specify)_____

The need for and capability to fund a research and development effort which occurs between established or normal budget cycles has led to many difficult decisions such as which projects to cut.

In one related discussion of R&D budgeting, the importance of asking eight basic questions of a candidate project for research and development fund allocation were specified:

"1. Can it be done?

2. Can the company do it?
3. Are the necessary resources likely to be available to successfully manufacture and market the product or to implement process improvements?
4. Is there a real demand or can one be created?
5. Can the product be profitably made and sold at a price which assures steady demand?
6. Is the company capable of successfully marketing the product?
7. What is the competition doing and how will it react?
8. How do the potential benefits compare with the apparent risks [Jones, 1973]?"

Question 5 attempted to determine which of the suggested, or other, reasons or policies for "between the cycle" funding changes was most used.

The reprogramming of R&D funds was accomplished mainly at periodic reviews by 61 percent of the companies. New opportunities or ideas were the basis for an additional 31 percent of the companies initiating funds reprogramming action. The remaining eight percent cited other reasons for reprogramming, including project failure and the competitive efforts of other companies. Each had less than three percent.

6. Personnel Assignment Method

Question 6. How are most personnel assigned to R & D projects?
(1) Hired and trained especially for the specific R & D effort
(2) Assigned as a result of past performance in other area
(3) Assigned from permanent R & D staff
(4) Hired to acquire specific technological capability
(5) Other (specify)_____

This question was intended to further clarify the acceptance or rejection of the fifth hypothesis regarding the importance of technological expertise, and to find if there were any predominant personnel policies in industrial practice.

The data indicated that personnel were assigned to R&D projects

from their permanent R&D staff by 59 percent of the companies, while an additional 22 percent indicated the R&D personnel assignments were made on the basis of past performance. Upon review, it was apparent that these two categories could be easily confused or both applicable in many cases. Therefore, no additional conclusions were made regarding the hypothesis. Over eight percent of the companies hired personnel for specific R&D tasks, six percent hired personnel for specific technological expertise, and four percent had other reasons for assigning personnel to R&D projects.

7. Percentage of R&D Contracted-Out

Question 7. What percentage of your R & D effort is subcontracted out?

	Less than 5%	5-25%	26-50%	51-75%	76-100%
Basic research	(1)	(2)	(3)	(4)	(5)
Applied research	(1)	(2)	(3)	(4)	(5)
Development	(1)	(2)	(3)	(4)	(5)

During the six years preceding 1973, Industrial R&D Laboratories in England had grown at a 25 percent per year rate. These laboratories perform research and development for different companies which increase the emphasis on ethical conduct of the laboratories [Sharples, 1973]. The literature suggested that, in England, an increasing number of companies were contracting-out some or most of their R&D effort. The above question was intended to obtain information on the amount and type of R&D effort contracted-out in the United States.

More than three-quarters of the responding companies contracted-out less than five percent of their total R&D effort in any category. The percentage of companies responding to this question in each R&D category with the indicated percentage of effort contracted-out is shown in Table 6.

TABLE 6

PERCENTAGE OF R&D EFFORT CONTRACTED-OUT

Percentage of R&D Effort Contracted-out	Percentage of Responding Companies		
	Basic Research	Applied Research	Development
Less than 5%	76.9	77.6	78.5
5-25%	10.4	14.0	13.9
26-50%	3.7	4.9	3.5
51-75%	2.2	0	0.7
76-100%	6.7	3.5	3.5

Table 6 shows that less than one-fourth of the companies contracted-out any significant proportion of their basic research. A relatively strong negative correlation was found between company size and basic research contracted-out, as indicated by a Kendall Tau of -0.25 with a significance of 0.001. This shows the tendency of the larger companies to perform their basic research within their own facilities.

A smaller percentage of the overall applied research and development was contracted-out than the basic research, as nearly 80 percent of the companies contracted-out less than five percent of their applied effort. The larger companies also performed in-house a larger percentage of both categories, applied research and development, than the smaller companies as verified by Kendall Taus of -0.20 and -0.22 respectively, each with a significance of 0.001.

One-half of the companies contracting-out more than 50 percent of their R&D effort were utility companies. One of these companies offered as a general comment "The R&D work among the electric utilities,

especially that conducted by the Electric Power Research Institute, constitutes a special case . . . "

8. Percentages of Externally Funded R&D

Question 8. What percentage of total R & D effort performed by your company is externally funded?

	Less than 5%	5-25%	26-50%	51-75%	76-100%
Government basic research	(1)	(2)	(3)	(4)	(5)
Government applied research	(1)	(2)	(3)	(4)	(5)
Government development	(1)	(2)	(3)	(4)	(5)
Other commercial basic research	(1)	(2)	(3)	(4)	(5)
Other commercial applied research	(1)	(2)	(3)	(4)	(5)
Other commercial development	(1)	(2)	(3)	(4)	(5)

Tables 7 and 8 show the percentage of responding companies conducting research and development effort in the various categories funded by government or other commercial sources respectively to the extent indicated.

TABLE 7

EXTERNAL R&D FUNDING BY GOVERNMENT SOURCES

Percentage of Externally Funded R&D	Percentage of Responding Companies		
	Basic Research	Applied Research	Development
Less than 5%	91.0	82.8	81.6
5-25%	1.5	6.7	7.4
26-50%	2.3	3.7	2.9
51-75%	0.8	3.0	2.9
76-100%	4.5	3.7	5.1

TABLE 8

EXTERNAL R&D FUNDING BY COMMERCIAL SOURCES

Percentage of Externally Funded R&D	Percentage of Responding Companies		
	Basic Research	Applied Research	Development
Less than 5%	93.1	89.6	87.6
5-25%	1.5	3.7	5.1
26-50%	2.3	2.2	2.2
51-75%	0	0	2.2
76-100%	3.1	4.4	2.9

Approximately two-thirds of the respondents to this question indicated less than five percent external funding in all six categories. Two companies reported 76 to 100 percent in all six categories.

9. Trends of Externally Funded R&D

Question 9. Of those efforts indicated in question 8 above, the following past five year trends have occurred:

	Increased	Decreased	Varied	Stable
Government basic research	(1)	(2)	(3)	(4)
Government applied research	(1)	(2)	(3)	(4)
Government development	(1)	(2)	(3)	(4)
Other commercial basic research	(1)	(2)	(3)	(4)
Other commercial applied research	(1)	(2)	(3)	(4)
Other commercial development	(1)	(2)	(3)	(4)

The histograms representing responses to Question 9 are summarized in Tables 9 and 10.

TABLE 9

PERCENTAGE TRENDS IN EXTERNALLY FUNDED R&D

R&D Category	*Percentage of Responding Companies			
	Increased	Decreased	Varied	Stable
Government basic research	9.7	16.8	3.5	69.9
Government applied research	14.8	13.0	3.5	68.7
Government development	21.4	9.4	6.0	63.2
Other commercial basic research	11.5	11.5	4.4	72.6
Other commercial applied research	18.6	5.9	5.9	69.5
Other commercial development	22.1	9.8	5.7	62.3

*Missing data omitted.

TABLE 10

NUMERICAL TRENDS IN EXTERNALLY FUNDED R&D

R&D Category	Number of Responding Companies				
	Increased	Decreased	Varied	Stable	Missing*
Government basic research	11	19	4	79	34
Government applied research	17	15	4	79	32
Government development	25	11	7	74	30
Other commercial basic research	13	13	5	82	34
Other commercial applied research	22	7	7	82	29
Other commercial development	27	12	7	76	25

*Respondents returning totally blank questionnaires not included.

The computer input data listing showed missing data in all categories for 21 respondents. For nearly all of these 21 companies, comments on the respective questionnaires indicated either that they do not conduct basic research, do not conduct any research, or internally fund 80 to 100 percent of all R&D. Therefore, trends in external funding were not appropriate for them. These comments were typical of several on other respondents' questionnaires wherein partial missing data were noted. The nature of at least one of the "exception" companies led to the conclusion that their research and development efforts were related to product markets and advertising.

Table 10 was included because inspection of the data base showed such a large amount of missing data for this question that the trend shown in Table 9 might be considered misleading or erroneous. The general trend shown in Table 10 agrees with the previous table thereby verifying that the missing data does not affect the results or analysis.

Both tables showed that the majority of companies reported stable research and development efforts. In fact, the input data also listed 58 companies that indicated stable externally funded R&D levels in all six tabulated categories. This represents approximately 40 percent of the total responding companies.

For further analysis, those companies that responded "increased" or "decreased" were considered by R&D category as a group. Tables 9 and 10 show a net decrease in government funded basic research, a balancing net effect in externally funded commercial basic research, and net increases in the other four categories. These data were considered to further support the first hypothesis which predicted a net increase trend of industrial companies, and was in agreement with the results

noted in Question 1 of Section Two which also showed a net increasing trend in total R&D by respondents.

10. R&D Evaluation Criterion

Question 10. What technique do you consider the most important in evaluating the return on investment or value of your overall R & D program?
(1) Number of commercial products developed
(2) Number of published technical articles
(3) Number of patents issued
(4) Cost savings estimates
(5) New process developments
(6) Market share trend
(7) Other (specify)_____

Various methods of evaluating R&D performance have been proposed, such as evaluating the individual performing the research, evaluating the group involved in the research, evaluating the organization performing the research, evaluating the product developed, and evaluating on a national basis. In evaluating the individual, techniques such as comparison with other organization members, ranking within the organization, weighted performance characteristics and the number of publications per individual are used. One method of group evaluation is to sum up the assessments of the individuals within the group; however, this can be misleading. Growth and profitability are usually the two standards for measuring the organization's performance; however, other factors contribute significantly, such as effectiveness and efficiency. Evaluating a developed product can be done from various viewpoints; however, it is usually evaluated for the contribution to the organization's objectives. Evaluating R&D on a national basis is usually very difficult; however, performance can be approximated if accomplishments can be identified and compared with original objectives and estimated costs [Roman, 1968].

Dr. William Thurow, of MIT, states that both civilian and military expenditures should be judged only on the direct benefits that they are supposed to be producing, and the spinoffs and economic multipliers should always be ignored in evaluating projects and allocating funds [Long, 1976]. This stand is very different from that taken by another senior economist who states that every one billion dollars spent in NASA R&D programs return approximately fourteen billion dollars over a ten year period, including spinoffs and related benefits [Gilison, 1976].

The above two cases indicated the difficulty in evaluating the value of R&D effort. Many industrial companies feel R&D is necessary for survival and prefer to evaluate the R&D programs subjectively while others attempt a quantified evaluation.

A suggested procedure for evaluating R&D is to attempt to:

"1. Determine the amount of profit produced and capable of being produced by each research and development project.

2. In the case of profits not yet materialized, discount the profits of future periods because of (a) the factor of uncertainty, (b) the prospect of changes that might reduce the profitability, and (c) the cost of money and other factors.

3. Apply a money value to other services performed by the research and development group, based on a market value agreed upon between the research and development staff and the department receiving the service.

4. Total the expenditures of the research and development group.

5. Subtract the total expenditures from the sum of discounted profits produced and services produced. If the result is a plus figure, it tends to indicate that the activity has been effective [Johnson, 1972]."

The difficulty of implementing the above procedure has been in arriving at quantified values for the steps of the procedure. Many times data were not available, probabilities of sales forecasts were wild guesses, and other values were products of wishful thinking. A study on

evaluating research and development by Professor J. B. Quinn led to the conclusion that R&D should be evaluated by a "segmental approach" [Quinn, September 1959]. This evaluation procedure called for a technical evaluation, an economic evaluation, and a management evaluation periodically to review each R&D project. Specific information was required for project reviews including (1) each program's cost to date, (2) what it had accomplished technically, (3) the value of this technology, (4) what investigations were projected, (5) the potential value of each and (6) how likely each was to succeed, economically and technically. Even when the segmental approach was utilized, no generally useful over-all formula for "how much to spend on R&D" was developed. Such guiding ratios as expenses to sales, expenses to capital, this year's to last year's expenses, and measured over-all return on R&D investments were of little value in research planning, according to Professor Quinn.

"Number of published technical articles" and "patents issued" were included as evaluators in some discussions of research and development.

The "other" answer in this question was included to attempt to discover additional evaluation factors which industry considered important.

A small number of respondents selected a "most important" factor of R&D program evaluation, and then added comments indicating additional equally or nearly as important factors. More than one-fourth of the additional respondents selected "other", and then offered specific comments. Appendix A includes a tabulation of all voluntary comments. These voluntary comments were analyzed and the two most numerous types of responses, "profit" and "other financially quantifiable," were computed. The total resulting responses received were organized as presented in Table 11.

TABLE 11

MOST IMPORTANT FACTORS IN R&D EVALUATION*

Factor	Number of Responses	Percentage of Total Responses**
Number of products	48	33.1
Published articles	0	0.0
Number of patents	0	0.0
Cost savings	18	12.4
New process developments	17	11.7
Market share trend	25	17.2
Profit	18	12.4
Other financially quantifiable	7	4.8
Other	12	8.3
Missing	2	

*Voluntary comments included.
**Missing values not included.

Approximately one-third of the respondents indicated the "number of commercial products developed" as being of prime importance. If the companies that selected "market share trend" (the second most frequently selected) and "number of commercial products developed" were combined as an indication of interest in maintaining a competitive position, this combined group represents one-half of the responding companies.

The next most frequently indicated evaluation factors were "cost savings," from the original question list, and "profit," discovered among the "other" comments. Each of these evaluation techniques or factors was indicated by 12 percent of the companies.

It was noted that only one company indicated in a comment that

"published technical articles" and "patents issued" were important as evaluative factors, but in that specific case neither was first in importance for that company.

When only cost savings, profit, and other financially quantifiable factors were considered, a total of 29 percent of the companies were represented. Number of commercial products developed, new process developments and market share trend were considered numerically quantifiable as to effect on company goals achievement. With existing accounting techniques, these last three factors were believed to be financially assessable as well. The factors discussed above as financially quantifiable were combined and the total effect was calculated. On this basis, over 90 percent of the responding companies indicated that some financially quantifiable benefit was the most important method of evaluating R&D effort.

The sixth hypothesis contended that financially quantifiable benefit of R&D effort is the most important factor in 60 percent of industrial evaluations. Therefore, the sixth hypothesis is accepted.

Two "other" comments were noted particularly because of the wide divergence between them. One respondent offered the evaluation formula of "sales of new products + 5x cost savings before tax + 5x royalties"; another, while indicating some factors are used, seemed to infer frustration or uncertainty by the comment "no real good technique ever found."

IV. VALIDATION OF HYPOTHESES

Six hypotheses were proposed as characteristics which, based on the literature reviewed, were expected to be confirmed by the data resulting from the survey of industry.

Contrary to expectations, the survey responses clearly rejected the second hypothesis, and marginally rejected the fourth hypothesis. The appropriate null hypotheses were accepted as stated in the analysis of results.

Within the rationale presented in the analysis of results, the other four hypotheses were accepted as validated by the survey results.

For clarity, the accepted hypotheses are presented as follows:

1. The trend of R&D effort levels in general is increasing at a net of ten percent of industrial corporations.

3. For two-thirds of sponsoring companies, less than five percent of basic research efforts yield financially profitable results within five years.

5. Availability/evaluation of technological expertise is the major factor in selection of the activity or individual to pursue the research and development effort in more than 70 percent of specific efforts.

6. Financially quantifiable benefit of R&D effort is the most important factor in 60 percent of industrial evaluations.

The rejected hypotheses are:

2. More than 50 percent of industry R&D efforts funding is based on a percentage of some financial index of the corporation concerned.

4. For two-thirds of performing companies, the majority of research efforts yielding results warranting follow-on development of new products, did so within four years of initiation.

V. PRINCIPAL FINDINGS AND CONCLUSIONS

The following principal findings and conclusions were derived from the survey response data as discussed in the analysis of results:

1. The percentage of responsive answers to the questionnaires distributed was greater than that of most analogous surveys reported in the literature reviewed. All segments of the survey population as measured by the number of laboratories operated, the company size and the industry classification were represented by data inputs. Therefore, it was concluded that the data analyzed was representative of the complete industrial frame specified for the survey.

2. The high percentage of executive interest in responding to the survey, as indicated by the titles of the responding officers, was concluded to confirm substantial validity of the policy indications shown by the data returned.

3. The respondents' perceived trends of R&D effort over the past five years strongly supported the first hypothesis which predicted an increasing trend.

4. Sixty-two percent of responding companies were classified by a National Science Foundation definition as not R&D intensive; that was, less than two percent of their total operating budget was devoted to research and development.

5. Sixty-one percent of the responding companies did not use any type of financial data index in the process of budgeting R&D funding levels. Accordingly, the null of the second hypothesis was accepted.

6. Of those companies that did use a financial index as an R&D budget basis, nearly two-thirds used a percent of sales as a controlling factor.

7. Eighty percent of reporting companies allocated less than five percent of their R&D effort to basic research. Nearly the opposite extreme, 60 percent of the companies devoted at least 60 percent of their R&D effort to development. The two factors rated as most important in evaluation of R&D effort were the number of new products developed and market share trend. When considered together with the above effort distribution, it was concluded that most companies devote the majority of their R&D effort toward maintaining or improving their position within their competitive industry as they perceive it.

8. Seventy-one percent of responding companies indicated that less than five percent of their basic research yielded financially profitable results within five years, thereby confirming acceptance of the third hypothesis. The responses of one-third of the companies confirmed acceptance of the null of the fourth hypothesis by indicating that the majority of research efforts pursued which yield results warranting follow-on development of new products required more than four years from initiation. Lead time to profitability was indicated as five to ten years from initial research by nearly 50 percent of respondents. From these facts, it was concluded that a substantial proportion of industry supported R&D efforts over sustained time periods.

9. More than 80 percent of the companies reporting in each of the three defined categories of research and development indicated that more than 80 percent of their efforts were internally funded.

10. More than 70 percent of the companies assigned tasks based on available in-house personnel either possessing the required technological background or who were adaptable with a minimum of training. This data was considered to be conclusive support for accepting the fifth hypothesis.

11. Fifty-four percent of the reporting companies indicated improving the company's competitive position by providing better products was the primary objective of their R&D effort.

12. Nearly one-half of the responding companies committed the funding level for R&D effort at the beginning of their budget planning phase.

13. Fifty-two percent of the companies purchased equipment as needed for specific tasks. Thirty-five percent purchased equipment to establish or maintain a general research capability. It was concluded therefore that each method was significantly used.

14. The periodic review cycle was indicated by 61 percent of the reporting companies as their most important policy criteria regarding reprogramming R&D funds.

15. More than three-fourths of companies reporting in each category contracted-out less than five percent of their R&D effort. Less than five percent external funding by either government or commercial sources was reported in each category by more than 80 percent of industry. When all budgeting and funding trends were considered together, it was concluded that the majority of the industrial companies surveyed generally preferred to conduct their own R&D in-house, and to accept relatively little R&D effort from outside sources.

16. Industry used a variety of factors as evaluators of return on investment or value of their R&D program. Over 90 percent of the factors indicated were considered quantifiable. With existing accounting techniques, those factors were believed to be financially assessable. Accordingly, the sixth hypothesis was accepted.

VI. RECOMMENDATIONS

The following actions are recommended:

1. That the principal findings and conclusions presented herein be adapted and considered as possible guidelines for decision criteria for use where appropriate, potentially in Navy research and development policy matters.

2. That a more in-depth study of the same industrial frame be conducted to discover related financial level data for coordination with the results presented herein.

3. That a parallel study be conducted relative to Federal, academic institution and non-profit (or not-for-profit) private organizations.

4. That the results of this study of industry and any results of those studies recommended above be combined to formulate a comprehensive research and development decision model.

APPENDIX A

Tabulation of Voluntary Comments

Several questions of the survey instrument included an answer such as "other" which the respondent might select if no otherwise suggested answer properly fitted his company's situation. These, and some additional answers, clearly invited or asked for a voluntary comment. The goal of this procedure was to clarify any indefinite answers. Also, if any particular answers should happen to be given a significant number of times, an important factor would be discovered which could have been overlooked otherwise. This procedure, for example, led to recognition of the relative importance of profit as an R & D effort evaluation method. Additional comments were sincerely invited at the end of the questionnaire.

All of the comments were considered during the analysis of responses. Recoding and re-analysis of answers to a particular question was done when the voluntary responses indicated a probable noticeable affect on the analysis of results.

All of the comments are tabulated in this appendix so that any reader may interpret any inference or application from them to his own company's procedures or policies.

To simplify and clarify presentation, and to aid in most meaningful interpretation, all voluntary answers or comments to a particular question are tabulated as a group. The questions are grouped according to the sections of the survey. The number of the question, and the question to which the comments were offered, is given at the beginning of the listing of comments to which it applies. For example, "SECTION TWO, Question Three" means that the list of comments following that heading all were offered in response to the third question of Section Two. In any list, the column headed "Serial No." gives the serial number of the questionnaire from which the comment following the number was recorded. If a particular comment is preceded by a number in parentheses, the number

in parentheses shows the answer to the particular question which the respondent selected before offering the comment. In all cases where no such number is shown, the respondent had either selected the last answer to the question (usually "other") or had added the comment in a general manner even though a comment had not been specifically sought. All comments offered by any particular respondent can be noted by correlating comments by questionnaire serial number from the several lists. All comments are quoted exactly from the questionnaire referenced by the serial number.

SECTION TWO - BUDGETARY CONSIDERATIONS

Question 1:

How do you perceive your company's R & D effort over the past five years?
(1) No significant change
(2) Increased significantly
(3) Decreased significantly
(4) Suspended R & D efforts

Serial No.	Comment
589	(2) (in dollars, but static as % of sales)

Question 2:

What percentage of your total operating budget does your R & D effort constitute?
(1) Less than 2%
(2) 2 to 4%
(3) 5 to 7%
(4) 8 to 10%
(5) Greater than 10%

Serial No.	Comment
257	If "your" means my own department, then 100%. If "your" means my company's corporate budget, then 5 to 7%.
274	NA

Question 3:

Annual R & D budgetary level is planned as:
(1) A percentage of net sales
(2) A percentage of net profit before taxes
(3) A percentage of net profit after taxes
(4) A percentage of total operating budget
(5) Specified other corporate financial index_____
(6) Limited to active contracts; i.e., no in-house development
(7) Not related to a financial index or factor of corporate operations. General basis is_____.

Serial No.	Comment
003	program need
004	Need of product programs
006	technical needs
021	perceived need
022	as justified
024	.15 mills/kwh
036	Project content & value
051	Project basis
056	need & financial health
059	whim
066	need
069	opportunity
071	dependent on project interest
076	Approved research program plus necessary but unanticipated research projects related to system operation
091	need
097	annual plan
098	as needed
112	Previous level + trends
113	corporate management spells out
129	judgement based on performance and business conditions
131	Potential of each project
136	Perceived need
141	Size of Staff
142	need for project efforts
145	Justification of need on individual project basis
153	number of good opportunities
155	continuing need for product improvement and development of new business opportunities
157	number and value of sugg. projects
163	need
166	need & value
173	Total cost of R & D
175	level of effort expressed as dollars identified in development plans prepared by operating divisions
177	historical
178	Corporate needs & opportunities
179	1 - 4 above plus
182	need for new technology in identified areas
197	status quo
203	Divisional Needs
213	profit potential of the R & D
216	need
237	discretionary
249	effort required to meet company goals
257	judgement whether (1) number of researchers we have is adequate, too low, or too high; (2) by project evaluations for potentials
274	resource requirements
278	Need For Technology
289	% above previous yr. spend % pretax before R & D allocation
307	what opportunities we identify

Question 3 (continued):

Serial No.	Comment
308	$ needed to accomplish program objectives
309	project and service activity
310	NO. of good objectives
315	5 year plans
320	need
323	as required by operating divisions
325	assigned personnel and recognized need
326	need
328	RD & E as a % of net sales
343	project or work forecast
351	projected profit
359	need for growth plans
360	continuity and opportunity
377	need
380	anticipated requirements
397	Division requirements
418	approved projects
423	As needs indicate
469	Programs
472	on evaluation of needs & opportunities
478	not budgeted
485	varied
497	need
501	long term % of profits
503	need
520	scope of programs at time of budget review - zero base budgeting
524	project merit
544	anticipated new product workload
545	customer demand
576	need
586	Market technical requirements
589	(1) (+ military products)

Question 4:

Total R & D budget is limited to:
(1) Not to exceed 2% of the above indicated financial index
(2) Not to exceed 4% of the above indicated financial index
(3) Not to exceed 7% of the above indicated financial index
(4) Not to exceed 10% of the above indicated financial index
(5) Other_____

Serial No.	Comment
004	no specific limit. However, influenced by percent of net sales
022	as justified
028	not limited
056	none
066	Offer services to the Div. & Corp. as required
076	as approved annually by management

Question 4 (continued):

Serial No.	Comment
091	need
098	determined at beginning of each fiscal year.
113	not related to a percentage
131	not applicable
132	Subject to divisional support
136	See #3 above (perceived need)
145	not applicable
153	not limited by financial index but runs under 4% of net sales
155	not applicable
166	established amount for each year
172	varies
173	negotiated ceilings & available earnings
175	No present limit - but budget is established as stated above
177	No financial index
178	Management Judgement
179	variable
182	Not limited. Based on reasonable need.
197	Financial justifications
203	Divisional needs
216	not limited
225	Finance index and operating need
257	Judgement on adequacy of research to meet perceived future needs
278	no fixed amount
289	30% of pretax before R & D allocation
307	No stipulated limit
308	determined by sum of program objectives
310	Secondary consideration about 3.5 - 5% of sales
315	Ability to meet objectives
320	not limited
323	no specific limitation
325	work to the capacity of assigned personnel and recognized need.
328	RD & E = 2.5%
337	Confidential
343	work approved
351	constant man or person power
359	No arbitrary guidelines
360	adjustments for inflation
377	amount of $ available
380	effect on overhead rates
418	N/A
423	no index
472	no specific limit
478	not budgeted
497	need
503	not limited
520	maintain budget
524	no specified limit

Question 4 (continued):

Serial No.	Comment
576	no budget limit
577	Approval of active projects
589	each division has own guidelines (varies from 2% to 10%)

Questions 5 through 13:

Questions 5 through 13 asked for percentages of funding, times to success or similar factors related to separating results of basic research, applied research and development. The comments given by those companies that did comment were so similar, and generally applied to more than one question identically, that all the comments are presented as a group for simplicity.

Serial No.	Comment
029	Ambiguous: 0% internally funded, 0% externally funded (No provision for indicating, 0 basic research)
036	N/A
056	No basic research as defined
066	No basic research done (0)
091	No basic research
098	Don't have any basic rsch
225	Experience too limited to answer.
343	not applicable
497	None or N/A
520	none
589	too unusual for statistical reply

SECTION THREE - GENERAL MANAGEMENT

Question 1:

Selection and assignment of a specific R & D task to an organizational group or individual is based primarily on:
(1) Availability of demonstrated project management expertise
(2) Availability of technological expertise in-house
(3) Formation of a new group incorporating both management and technological expertise (includes organizational reassignment)
(4) Availability of support personnel
(5) If capability not existant in-house, contract to best qualified management sub-contractor
(6) If capability not existant in-house, contract to best qualified technologically qualified sub-contractor.
(7) Available in-house personnel with best background adaptable with minimum training
(8) Other_____

Serial No.	Comment
004	Depending on project, could be 1, 2, 3, 7.
019	varies 7, 2, 6 in order

Question 1 (continued):

Serial No.	Comment
024	#2, 5, &6
084	Responsibility of organization or individual
098	Automatically to engineering dept.
177	Nature of assignment
178	Capability, availability & overall priorities (8)

Question 2:

Which R & D project objective would get highest priority at your company?

(1) Reducing operating costs of processes
(2) Timeliness (with respect to_____)
(3) Improving company's competitive position by providing better products
(4) Probability of success of R & D project
(5) Soundness of technological approach
(6) Estimated cost
(7) Product diversification for company growth
(8) Other (specify)_____

Serial No.	Comment
004	Depends on all factors listed plus others
019	All above
021	No simple answer adequate
044	(2) tech need
066	(3), 7 a close second
076	(2) company objectives
089	New method of producing natural gas
100	New products
113	New supplies of natural gas
142	(2) government regulations
153	Generate highest profit potential. Includes 1, 2 & 3.
167	size of market for product to be developed
178	Potential for successful new product
213	net profit potential
225	(2), paper flow & 3.
278	(1) Answers (3), (4), (6) or (7) may be of highest priority in many projects
305	depends on profit centers needs & cost or risk or benefit ratios
310	balance of 1, 3, 4, 5
325	(2) Government Agency Permits and Regulatory deadlines
359	potential value of project - profit
360	no single item controlling
397	varies with division
423	most pressing need
465	(2) resource availability
478	(2) competition
544	(2) line extensions of existing products

Question 3:

At what stage in the budget formulation process is the funding level committed for R & D?
(1) Beginning of the planning phase
(2) When sales estimates are made
(3) When profit estimates are made
(4) At end of budget allocation, providing funds are available
(5) Other (specify)_____

Serial No.	Comment
004	At end, but given same consideration as other functions. Reviewed annually or more often if changes take place.
024	Public Service Commission Determination
028	Total Integrated Planning Cycle
076	after approval of R & D projects
089	as required
172	as part of a total corporate program on budget formation
177	annually
178	when proposed programs (total) are reviewed by mgt.
213	when profit net potential defined
278	Subject to Critical Review at all Phases.
325	Not fiscally budgeted, see II - 3.
359	same time as total co. budget approved.
360	Separate budget submitted for Board Approval
397	after approval of project justification
478	not budgeted
519	never
524	at end of yearly planning cycle
544	tied to fiscal year
586	When total corp financial plan is prepared for Board of Directors

Question 4:

If you anticipate equipment requirements for R & D effort in addition to current R & D capability, your most common acquisition method is:
(1) Purchase to establish or maintain general research capability
(2) Purchase for specific R & D task
(3) Transfer to R & D upon completion of other usage
(4) Develop in-house as need arises
(5) Other (specify)_____

Serial No.	Comment
004	Combination of 1, 2 & 4.
112	1 + 4 above
249	Lease with purchase option
360	combination of 1 and 2
501	varies considerably with circumstances
542	Varies with the project

Question 5:

What is the most important criteria of your policy regarding reprogramming of R & D funds?
(1) As new opportunities or ideas are generated
(2) Upon failure of existing R & D projects to materialize useful results/products
(3) Based on periodic review of all ongoing efforts
(4) Observed/predicted major shift of competitor's direction of effort
(5) Other (specify)_____

Serial No.	Comment
004	1, 2, 3, 4 all play a part and most cause reprogramming R & D.
019	In order 1, 3 + 4 of above
161	combination of 1 & 3
237	(3) 80%, (1) 20%
520	3 & 4

Question 6:

How are most personnel assigned to R & D projects?
(1) Hired and trained especially for the specific R & D effort
(2) Assigned as a result of past performance in other area
(3) Assigned from permanent R & D staff
(4) Hired to acquire specific technological capability
(5) Other (specify)_____

Serial No.	Comment
019	varied
076	combination of 2, 3 & 4
131	varies greatly - all the above
542	Combination of above

Question 7:

What percentage of your R & D effort is subcontracted out?

	Less than 5%	5-25%	26-50%	51-75%	76-100%
Basic research	(1)	(2)	(3)	(4)	(5)
Applied research	(1)	(2)	(3)	(4)	(5)
Development	(1)	(2)	(3)	(4)	(5)

Serial No.	Comment
123	NA (for basic research)
227	(0) Much of our development is done jointly with mfgrs.
497	None or N/A
542	(0) Info is not avail to me.

Questions 8 and 9:

Questions 8 and 9 asked for percentages and trends of funding from external government or commercial sources to support basic research, applied research or development effort. Comments received were generalized and usually applied to both questions.

Serial No.	Comment
029	No Gov't Support
066	(1) No outside funding
112	don't do (gov't research, basic & applied)
123	(indicated "NA" for all basic res. cats.)
177	none
225	Experience too limited to answer
227	Much of our development is done jointly (answered 0)
457	Not applicable
497	None or N/A
520	none (except commercial development)
542	Best guess answers

Question 10:

What technique do you consider the most important in evaluating the return on investment or value of your overall R & D program?
(1) Number of commercial products developed
(2) Number of published technical articles
(3) Number of patents issued
(4) Cost savings estimates
(5) New process developments
(6) Market share trend
(7) Other (specify)_____

Serial No.	Comment
003	Sales of new products + 5x cost savings before tax + 5x royalties
004	combination of 1 & 6.
019	The $ value of the successful projects for the operative groups.
021	Earnings record of new products & processes
022	resulting contribution to profits
024	#4 & 5
029	The number of quality commercial products which are being marketed successfully & profitably
044	Application of results
066	number of projects that are transferred to a production product or process. We are designated as an R & D department however we primarily do product, process, and mfg. devel. and test work for the various mfg. divisions.
076	use of information or process by co. or customers within 5-10 yrs.
084	Value of commercialized projects
091	Profits
097	Profit from products developed
113	We do no basic research
131	Profitability of products developed
136	Effect of new projects on earnings.
155	(1) & 5
161	sales & net income resulting from R & D efforts
167	projected profit from the programs
178	Profit impact of new products plus product & process modifications.

Question 10 (continued):

Serial No.	Comment
182	Probable value to probable cost ratio
192	We are not an R & D company, you should improve your mailing list.
213	profits generated
227	The company engages in virtually no research. The development phases are conducted jointly by the company and suppliers of products that we provide (via leasing) to our customers.
237	Change in return on investment
278	Whether technology needed for efficient company operations has been provided.
290	Profit generated
300	(1), 2, 3, 4, 5
305	demand from company's profit centers for our technical efforts and participation.
315	Profits generated traceable to R & D
323	profits generated as a result of R & D programs
343	No real good technique ever found
351	Satisfaction as stated by the R & D sponsor which may be any of the above, but generally (1), (4), (5), (6).
359	Profit on long term basis
360	Benefits to corporation established and verified by accounting Department
380	New program wins
423	Return of funds expended, bottom line profitability
451	4 and 5
472	Estimated present worth & probability of success.
478	New market development
520	(1) 1 & 5 & 4 about equal depending on R & D group
542	1, 4 & 5
544	Our group is small. 13 professional employees, 7 non-professional, 4 clerical, 1 janitor. The retail food products activity in most food companies has most of the R & D funds. This ranges generally from 0.1% to 1.0% of sales. Ours is 0.1%.
570	estimate of value activities.
586	This response does not include any of our government R & D contract which exceeds the corporately sponsored by almost an order of magnitude

Additional General Comments:

Serial No.	Comment
024	The R & D work among the electric utilities, especially that conducted by the Electric Power Research Institute constitutes a special case but does not generally fall within much of the above categorization.
325	Questions have been answered in terms of the only R & D laboratory facility in the company. However, the total R & D effort of the company is several times larger than the laboratory's.

Additional General Comments (continued):

Serial No.	Comment
589	A reasonably good questionnaire. Might consider relating R & D level to degree of maturity of each technical area, or to rate of growth of market. In some questions such as #1 and #6 of last section, an ordering would yield more information than selecting a single item.

Additional appropriate comments from company letters forwarded with returned questionnaires:

> ...Almost everything we do is on a first time basis and therefore there is no trend.
>
> (We) Use outside consultants with technological expertise to implement DEVELOPMENT to reduce operating costs of processes.
>
> With respect to Section Three of the form, where you have chosen words such as "primarily, highest, most," etc. you may have obtained a truer picture if you had invited weighting among the top 3. Decisions are usually made on the basis of several factors.

APPENDIX B

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA - 93940

IN REPLY REFER TO:

Code 55
0001-2

Dear Sir:

The Naval Postgraduate School has initiated a study effort to develop an improved decision model, technique, or criterion for project selection and evaluation which may be made applicable to United States Navy research and development planning. The questionnaire forwarded herewith is designed to survey general management and decision making techniques practiced by industry as guides to development of factors for Navy use.

As your organization is a prominent leader in American industry, your inputs to this survey are ardently sought, and will contribute very substantially to the validity and utility of any assessments forthcoming. Early return of the completed questionnaire in the return envelope provided will be greatly appreciated.

All information provided will be maintained as confidential; only aggregate numbers, statistical factors and trend analysis will be released as analysis information.

Thank you for your valuable assistance.

Yours truly,

J. W. Creighton,
Professor of Management

JWC/ls

SURVEY OF RESEARCH AND DEVELOPMENT MANAGEMENT

General Instructions

Definitions of basic and applied research seem not to differ significantly among the Department of Defense, the National Science Foundation, academic institutions and industry. Development activities are, however, on occasion organizationally segmented into development, testing, evaluation, laboratory, design and other categories. Accordingly, for purposes of consistency in response to this questionnaire, the following definitions are provided to assist in interpretation of questions and potential comparison with other studies.

BASIC RESEARCH includes original investigations for the advancement of scientific knowledge that do not have specific commercial objectives, although such investigations may be in the field of present or potential interest of the reporting company.

APPLIED RESEARCH includes investigations directed to the discovery of new scientific knowledge that has specific commercial objectives with respect to products or processes . . . applied research differs from . . basic research chiefly in terms of the objectives of the reporting company.

DEVELOPMENT includes technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes. Development does not include routing technical services or other activities excluded from research and development.

In order to provide a more consistent point of reference for your answers, we suggest that you scan the entire questionnaire prior to answering any of the questions. In your replies to this questionnaire, please treat your research and development facilities as a single group or entity.

Please enter the most appropriate answer in the box at the right of each question number for the appropriate box or boxes. If the question calls for a response of more than a one digit response please place "ONLY" one digit per box. Disregard the numbers to the right of the boxes.

SECTION ONE - BACKGROUND INFORMATION

1. How many research and/or development laboratories or facilities does your company operate?
   (1) one, (2) 2 to 5, (3) 6 to 10, (4) 11 to 15, (5) over 15 — 1. ☐ 1

2. Your company size as indicated by total number of employees:
   (1) Less than 5,000 (3) 10,000 to 19,999 (5) 40,000 to 79,999
   (2) 5,000 to 9,999 (4) 20,000 to 39,999 (6) 80,000 or more — 2. ☐ 2

3. As a very general industry classifcation, the greater portion of your company's activities would be:
   (1) Durable goods industry (3) Services industry
   (2) Non-durable goods industry (4) Diversified industry — 3. ☐ 3

4. (Optional) Please specify your official title in the company organization._____ — 4. ☐ 4

SECTION TWO - BUDGETARY CONSIDERATIONS

1. How do you perceive your company's R & D effort over the past five years?
   (1) No significant change (3) Decreased significantly
   (2) Increased significantly (4) Suspended R & D efforts

1. [ ] 5

2. What percentage of your total operating budget does your R & D effort constitute?
   (1) Less than 2% (3) 5 to 7% (5) Greater than 10%
   (2) 2 to 4% (4) 8 to 10%

2. [ ] 6

3. Annual R & D budgetary level is planned as:
   (1) A percentage of net sales
   (2) A percentage of net profit before taxes
   (3) A percentage of net profit after taxes
   (4) A percentage of total operating budget
   (5) Specified other corporate financial index_____
   (6) Limited to active contracts; i.e., no in-house development
   (7) Not related to a financial index or factor of corporate operations. General basis is_____.

3. [ ] 7

4. Total R & D budget is limited to:
   (1) Not to exceed 2% of the above indicated financial index
   (2) Not to exceed 4% of the above indicated financial index
   (3) Not to exceed 7% of the above indicated financial index
   (4) Not to exceed 10% of the above indicated financial index
   (5) Other_____

4. [ ] 8

5. What percentage of R & D effort is directed toward basic research?
   (1) Less than 5% (3) 10 to 14% (5) 20% or greater
   (2) 5 to 9% (4) 15 to 19%

5. [ ] 9

6. What percentage of R & D effort is directed toward applied research?
   (1) Less than 10% (3) 20 to 29% (5) 40 to 49%
   (2) 10 to 19% (4) 30 to 39% (6) 50% or greater

6. [ ] 10

7. What percentage of R & D effort is directed toward development projects?
   (1) Less than 20% (3) 40 to 59% (5) 80 to 100%
   (2) 20 to 39% (4) 60 to 79%

7. [ ] 11

8. What percentage of basic research projects yield financially profitable results withing five years of initial research?
   (1) Less than 2% (3) 5 to 7% (5) Greater than 10%
   (2) 2 to 4% (4) 8 to 10%

8. [ ] 12

9. Of those basic and applied research efforts that lead to a decision to go ahead with development, the majority of them involve a time period from initiation to development decision of:
   (1) Less than 2 years (3) 5 to 10 years (5) More than 20 years
   (2) 2 to 4 years (4) 11 to 20 years

9. [ ] 13

10. Of those R & D projects that lead to useful or profitable products, the majority of them involve a time period from initiation to profit of:
    (1) Less than 2 years (3) 5 to 10 years (5) More than 20 years
    (2) 2 to 4 years (4) 11 to 20 years

10. [ ] 14

11. What percentage of your basic research effort is internally funded?
    (1) Less than 20% (3) 40 to 59% (5) 80 to 100%
    (2) 20 to 39% (4) 60 to 79%

11. [ ] 15

12. What percentage of your applied research effort is internally funded?
(1) Less than 20% (3) 40 to 59% (5) 80 to 100%
(2) 20 to 39% (4) 60 to 79%

12. [ ] 16

13. What percentage of your development effort is internally funded?
(1) Less than 20% (3) 40 to 59% (5) 80 to 100%
(2) 20 to 39% (4) 60 to 79%

13. [ ] 17

SECTION THREE - GENERAL MANAGEMENT

1. Selection and assignment of a specific R & D task to an organizational group or individual is based primarily on:
(1) Availability of demonstrated project management expertise
(2) Availability of technological expertise in-house
(3) Formation of a new group incorporating both management and technological expertise (includes organizational reassignment)
(4) Availability of support personnel
(5) If capability not existant in-house, contract to best qualified management sub-contractor
(6) If capability not existant in-house, contract to best qualified technologically qualified sub-contractor.
(7) Available in-house personnel with best background adaptable with minimum training
(8) Other_____

1. [ ] 18

2. Which R & D project objective would get highest priority at your company?
(1) Reducing operating costs of processes
(2) Timeliness (with respect to _____)
(3) Improving company's competitive position by providing better products
(4) Probability of success of R & D project
(5) Soundness of technological approach
(6) Estimated cost
(7) Product diversification for company growth
(8) Other (specify)_____

2. [ ] 19

3. At what stage in the budget formulation process is the funding level committed for R & D?
(1) Beginning of the planning phase
(2) When sales estimates are made
(3) When profit estimates are made
(4) At end of budget allocation, providing funds are available
(5) Other (specify)_____

3. [ ] 20

4. If you anticipate equipment requirements for R & D effort in addition to current R & D capability, your most common acquisition method is:
(1) Purchase to establish or maintain general research capability
(2) Purchase for specific R & D task
(3) Transfer to R & D upon completion of other usage
(4) Develope in-house as need arises
(5) Other (specify)_____

4. [ ] 21

5. What is the most important criteria of your policy regarding reprogramming of R & D funds?
(1) As new opportunities or ideas are generated
(2) Upon failure of existing R & D projects to materialize useful results/products
(3) Based on periodic review of all ongoing efforts
(4) Observed/predicted major shift of competitor's direction of effort
(5) Other (specify)_____

5. [ ] 22

6. How are most personnel assigned to R & D projects?
   (1) Hired and trained especially for the specific R & D effort
   (2) Assigned as a result of past performance in other area
   (3) Assigned from permanent R & D staff
   (4) Hired to acquire specific technological capability
   (5) Other (specify)_____

6. [ ] 23

7. What percentage of your R & D effort is subcontracted out?

	Less than 5%	5-25%	26-50%	51-75%	76-100%
Basic research	(1)	(2)	(3)	(4)	(5)
Applied research	(1)	(2)	(3)	(4)	(5)
Development	(1)	(2)	(3)	(4)	(5)

7. [ ] 24
   [ ] 25
   [ ] 26

8. What percentage of total R & D effort performed by your company is externally funded?

	Less than 5%	5-25%	26-50%	51-75%	76-100%
Government basic research	(1)	(2)	(3)	(4)	(5)
Government applied research	(1)	(2)	(3)	(4)	(5)
Government development	(1)	(2)	(3)	(4)	(5)
Other commercial basic research	(1)	(2)	(3)	(4)	(5)
Other commercial applied research	(1)	(2)	(3)	(4)	(5)
Other commercial development	(1)	(2)	(3)	(4)	(5)

8. [ ] 27
   [ ] 28
   [ ] 29
   [ ] 30
   [ ] 31
   [ ] 32

9. Of those efforts indicated in question 8 above, the following past five year trends have occurred:

	Increased	Decreased	Varied	Stable
Government basic research	(1)	(2)	(3)	(4)
Government applied research	(1)	(2)	(3)	(4)
Government development	(1)	(2)	(3)	(4)
Other commercial basic research	(1)	(2)	(3)	(4)
Other commercial applied research	(1)	(2)	(3)	(4)
Other commercial development	(1)	(2)	(3)	(4)

9. [ ] 33
   [ ] 34
   [ ] 35
   [ ] 36
   [ ] 37
   [ ] 38

10. What technique do you consider the most important in evaluating the return on investment or value of your overall R & D program?
   (1) Number of commercial products developed
   (2) Number of published technical articles
   (3) Number of patents issued
   (4) Cost savings estimates
   (5) New process developments
   (6) Market share trend
   (7) Other (specify)_____

10. [ ] 39

Additional comments are sincerely invited.

THANK YOU FOR YOUR ASSISTANCE.

```
VAR001     NUMBER OF LABORATORIES
     CODE
            I
       1.   ********************** (     39)
            I  ONE
            I
       2.   ********************************** (     59)
            I  2 TO 5
            I
       3.   ************ (     24)
            I  6 TO 10
            I
       4.   ***** (      7)
            I  11 TO 15
            I
       5.   ******** (     13)
            I  OVER 15
            I
        0   **** (      5)
(MISSING)   I
            I
            I.........I.........I.........I.........I.........I
            0         20        40        60        80        100
            FREQUENCY

MEAN            2.268       STD ERR          .099       MEDIAN          2.042
MODE            2.000       STD DEV         1.185       VARIANCE        1.403
KURTOSIS         .249       SKEWNESS         .987       RANGE           4.000
MINIMUM         1.000       MAXIMUM         5.000       SUM           322.000
C.V. PCT       52.236       .95 C.I.        2.071             TO        2.464

VALID CASES       142       MISSING CASES       5
```

```
VAR002    COMPANY SIZE
     CODE
               I
     1.00 ****** (      9)
          I  UNDER   5,000
               I
     2.00 ************** (     25)
          I  5,000 TO 9,999
               I
     3.00 ****************************** (     54)
          I  10,000 - 19,999
               I
     4.00 ***************** (     29)
          I  20,000 - 39,999
               I
     5.00 ********** (     20)
          I  40,000 - 79,999
               I
     6.00 ****** (     10)
          I  80,000  OR MORE
               I
               I.........I.........I.........I.........I.........I
               0         20        40        60        80        100
               FREQUENCY

MEAN            3.381      STD ERR          .105      MEDIAN          3.231
MODE            3.000      STD DEV         1.279      VARIANCE        1.635
KURTOSIS        -.436      SKEWNESS         .267      RANGE           5.000
MINIMUM         1.000      MAXIMUM         6.000      SUM           497.000
C.V. PCT       37.816      .95 C.I.        3.173           TO         3.589

VALID CASES       147      MISSING CASES       0
```

```
VAR003    INDUSTRY CLASSIFICATION
     CODE
          I
     1.00 ************************************************** (    49)
          I  DURABLE  GOODS
          I
     2.00 ********************************************** (    45)
          I  CONSUMED GOODS
          I
     3.00 ********************* (    19)
          I  SERVICES
          I
     4.00 ************************************ (    34)
          I  DIVERSIFIED
          I
          I.........I.........I.........I.........I.........I
          0         10        20        30        40        50
          FREQUENCY
```

MEAN	2.259	STD ERR	.095	MEDIAN	2.044
MODE	1.000	STD DEV	1.153	VARIANCE	1.330
KURTOSIS	-1.278	SKEWNESS	.398	RANGE	3.000
MINIMUM	1.000	MAXIMUM	4.000	SUM	332.000
C.V. PCT	51.062	.95 C.I.	2.071	TO	2.446
VALID CASES	147	MISSING CASES	0		

```
VAR004     RESPONDENT CORPORATE LEVEL
     CODE
               I
     1.00 ********************************* (     57)
               I  PRES OR  V.P.
               I
     2.00 ********************************* (     56)
               I  SEGMENT DIRECTOR
               I
     3.00 ********** (     18)
               I  MAJOR   DEPT HD
               I
     4.00 ********* (     16)
               I  UNIDENT
               I
               I.........I.........I.........I.........I.........I
               0         20        40        60        80        100
               FREQUENCY
```

MEAN	1.952	STD ERR	.080	MEDIAN	1.795
MODE	1.000	STD DEV	.975	VARIANCE	.950
KURTOSIS	-.325	SKEWNESS	.808	RANGE	3.000
MINIMUM	1.000	MAXIMUM	4.000	SUM	287.000
C.V. PCT	49.917	.95 C.I.	1.794	TO	2.111

VALID CASES	147	MISSING CASES	0

```
VAR005    R AND D EFFORT TREND
     CODE
          I
     1.00 ************************************ (    68)
          I  NO      CHANGE
          I
     2.00 ************************************ (    66)
          I  MARKED  INCREASE
          I
     3.00 ******** (    13)
          I  MARKED  DECREASE
          I
          I.........I.........I.........I.........I.........I
          0         20        40        60        80        100
          FREQUENCY
```

MEAN	1.626	STD ERR	.053	MEDIAN	1.583
MODE	1.000	STD DEV	.643	VARIANCE	.414
KURTOSIS	-.661	SKEWNESS	.530	RANGE	2.000
MINIMUM	1.000	MAXIMUM	3.000	SUM	239.000
C.V. PCT	39.568	.95 C.I.	1.521	TO	1.731

VALID CASES 147 MISSING CASES 0

```
VAR006     PERCENT OF OPERATING BUDGET
     CODE
           I
     1.00  ************************************************** (     89)
           I  UNDER 2
           I
     2.00  ********************* (     37)
           I  2 TO 4
           I
     3.00  ****** (      9)
           I  5 TO 7
           I
     4.00  ** (      2)
           I  8 TO 10
           I
     5.00  **** (      5)
           I  OVER 10
           I
        0  **** (      5)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY


MEAN           1.570      STD ERR          .079      MEDIAN         1.298
MODE           1.000      STD DEV          .941      VARIANCE        .885
KURTOSIS       4.383      SKEWNESS        2.078      RANGE          4.000
MINIMUM        1.000      MAXIMUM         5.000      SUM          223.000
C.V. PCT      59.906      .95 C.I.        1.414           TO        1.726

VALID CASES      142      MISSING CASES      5
```

```
VAR007    FINANCIAL INDEX
     CODE
           I
     1.00 ***************** (     30)
           I  NET      SALES
           I
     2.00 ** (      2)
           I  PROFIT  B.TAXES
           I
     3.00 *** (      3)
           I  PROFIT  A. TAXES
           I
     4.00 ******* (     12)
           I  TOTAL    BUDGET
           I
     5.00 *** (      3)
           I  OTHER    INDEX
           I
     6.00 **** (      6)
           I  OUTSIDE FINANCED
           I
     7.00 ********************************************** (     88)
           I  NOT      RELATED
           I
        0 *** (      3)
(MISSING) I
           I
           I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY
```

MEAN	5.264
MODE	7.000
KURTOSIS	-.897
MINIMUM	1.000
C.V. PCT	46.857
VALID CASES	144
STD ERR	.206
STD DEV	2.467
SKEWNESS	-.931
MAXIMUM	7.000
.95 C.I.	4.858
MISSING CASES	3
MEDIAN	6.682
VARIANCE	6.084
RANGE	6.000
SUM	758.000
TO	5.670

```
VAR008     PERCENT OF INDEX
     CODE
           I
     1.00 ************ (     22)
           I  NO MORE THAN  2
           I
     2.00 ******* (     12)
           I  NO MORE THAN  4
           I
     3.00 ** (      1)
           I  NO MORE THAN  7
           I
     4.00 *** (      3)
           I  NO MORE THAN 10
           I
     5.00 ********************************************** (     90)
           I  OTHER
           I
        0 ********** (     19)
(MISSING) I
           I
           I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY

MEAN           3.992      STD ERR          .144      MEDIAN         4.789
MODE           5.000      STD DEV         1.629      VARIANCE       2.653
KURTOSIS       -.694      SKEWNESS       -1.085      RANGE          4.000
MINIMUM        1.000      MAXIMUM         5.000      SUM          511.000
C.V. PCT      40.803      .95 C.I.        3.707           TO        4.277

VALID CASES      128      MISSING CASES     19
```

```
VAR009     R AND D PERCENT-BASIC RESEARCH
     CODE
              I
     1.00 ********************************* (   117)
              I  UNDER 5
              I
     2.00 **** (    10)
              I  5 TO 9
              I
     3.00 *** (     7)
              I  10 TO 14
              I
     4.00 *** (     7)
              I  15 TO 19
              I
     5.00 ** (     5)
              I  20 PLUS
              I
        0 * (     1)
(MISSING) I
              I
              I.........I.........I.........I.........I.........I
              0         40        80        120       160       200
              FREQUENCY


MEAN          1.445     STD ERR        .085     MEDIAN        1.124
MODE          1.000     STD DEV       1.024     VARIANCE      1.049
KURTOSIS      4.218     SKEWNESS      2.313     RANGE         4.000
MINIMUM       1.000     MAXIMUM       5.000     SUM         211.000
C.V. PCT     70.859     .95 C.I.      1.278           TO      1.613

VALID CASES    146     MISSING CASES     1
```

```
VAR010    R AND D PERCENT-APPLIED RESEARCH
     CODE
          I
     1.00 ********************************* (    29)
          I  UNDER 10
          I
     2.00 ****************************************** (    36)
          I  10 TO 19
          I
     3.00 *************************** (    24)
          I  20 TO 29
          I
     4.00 ***************** (    15)
          I  30 TO 39
          I
     5.00 ******************** (    18)
          I  40 TO 49
          I
     6.00 **************************** (    25)
          I  50 PLUS
          I
          I.........I.........I.........I.........I.........I
          0         10        20        30        40        50
          FREQUENCY

MEAN          3.218     STD ERR         .146     MEDIAN        2.854
MODE          2.000     STD DEV        1.769     VARIANCE      3.130
KURTOSIS     -1.264     SKEWNESS        .330     RANGE         5.000
MINIMUM       1.000     MAXIMUM        6.000     SUM         473.000
C.V. PCT     54.986     .95 C.I.       2.929           TO      3.506

VALID CASES     147     MISSING CASES     0
```

```
VAR011     R AND D PERCENT-DEVELOPMENT
     CODE
          I
     1.00 *****  (      7)
          I  UNDER 20
          I
     2.00 *******  (     11)
          I  20 TO 39
          I
     3.00 **********************  (     40)
          I  40 TO 59
          I
     4.00 ********************  (     37)
          I  60 TO 79
          I
     5.00 ****************************  (     52)
          I  80 PLUS
          I
          I.........I.........I.........I.........I.........I
          0         20        40        60        80        100
          FREQUENCY

MEAN            3.789      STD ERR          .095      MEDIAN          3.919
MODE            5.000      STD DEV         1.148      VARIANCE        1.318
KURTOSIS        -.366      SKEWNESS        -.644      RANGE           4.000
MINIMUM         1.000      MAXIMUM         5.000      SUM           557.000
C.V. PCT       30.301      .95 C.I.        3.602                TO     3.976

VALID CASES       147      MISSING CASES       0
```

```
VAR012    PERCENT PROFITABLE-FIVE YEARS
     CODE
          I
     1.00 ********************************************** (    83)
          I  UNDER  2
          I
     2.00 *** (     4)
          I  2 TO 4
          I
     3.00 ****** (     9)
          I  5 TO 7
          I
     4.00 ****** (    10)
          I  8 TO 10
          I
     5.00 ********* (    16)
          I  OVER 10
          I
        0 ************** (    25)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         20        40        60        80        100
          FREQUENCY

MEAN          1.951      STD ERR        .137      MEDIAN        1.235
MODE          1.000      STD DEV       1.509      VARIANCE      2.279
KURTOSIS       -.371     SKEWNESS      1.155      RANGE         4.000
MINIMUM       1.000      MAXIMUM       5.000      SUM         238.000
C.V. PCT     77.377      .95 C.I.      1.680           TO       2.221

VALID CASES     122      MISSING CASES    25
```

```
VAR013    DEVELOPMENT GO AHEAD - YEARS
     CODE
          I
     1.00 ****************** (    31)
          I  UNDER 2
          I
     2.00 ********************************** (    63)
          I  2 TO 4
          I
     3.00 ************************ (    44)
          I  5 TO 10
          I
     4.00 *** (     4)
          I  11 TO 20
          I
        0 **** (     5)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         20        40        60        80        100
          FREQUENCY
```

MEAN	2.148	STD ERR	.066	MEDIAN	2.135
MODE	2.000	STD DEV	.790	VARIANCE	.623
KURTOSIS	-.719	SKEWNESS	.080	RANGE	3.000
MINIMUM	1.000	MAXIMUM	4.000	SUM	305.000
C.V. PCT	36.759	.95 C.I.	2.017	TO	2.279
VALID CASES	142	MISSING CASES	5		

```
VAR014    LEAD TIME TO PROFIT - YEARS
     CODE
           I
     1.00 ********** (     17)
           I  UNDER 2
           I
     2.00 ************************** (     47)
           I  2 TO 4
           I
     3.00 ************************************** (     72)
           I  5 TO 10
           I
     4.00 ****** (      9)
           I  11 TO 20
           I
        0 ** (      2)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY
```

MEAN	2.503	STD ERR	.065	MEDIAN	2.618
MODE	3.000	STD DEV	.783	VARIANCE	.613
KURTOSIS	-.405	SKEWNESS	-.360	RANGE	3.000
MINIMUM	1.000	MAXIMUM	4.000	SUM	363.000
C.V. PCT	31.270	.95 C.I.	2.375	TO	2.632

VALID CASES	145	MISSING CASES	2

```
VAR015    PERCENT BASIC INTERNALLY FUNDED
     CODE
           I
     1.00 ***** (     15)
           I  UNDER 20
           I
     2.00 ** (      2)
           I  20 TO 39
           I
     3.00 ** (      3)
           I  40 TO 59
           I
     4.00 ** (      2)
           I  60 TO 79
           I
     5.00 ***************************** (    105)
           I  OVER 80
           I
        0 ****** (     20)
(MISSING) I
           I
           I.........I.........I.........I.........I.........I.........I
           0         40         80        120        160        200
           FREQUENCY


MEAN            4.417      STD ERR          .120      MEDIAN          4.895
MODE            5.000      STD DEV         1.348      VARIANCE        1.817
KURTOSIS        2.184      SKEWNESS       -2.001      RANGE           4.000
MINIMUM         1.000      MAXIMUM         5.000      SUM           561.000
C.V. PCT       30.511      .95 C.I.        4.181           TO         4.654

VALID CASES       127      MISSING CASES     20
```

AD-A033 739 NAVAL POSTGRADUATE SCHOOL MONTEREY CALIF F/G 5/1
A SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT BUDGETING, EFFO--ETC(U)
SEP 76 H C FISH, J W WILSON
UNCLASSIFIED NPS-54CF76092 NL

2 OF 2
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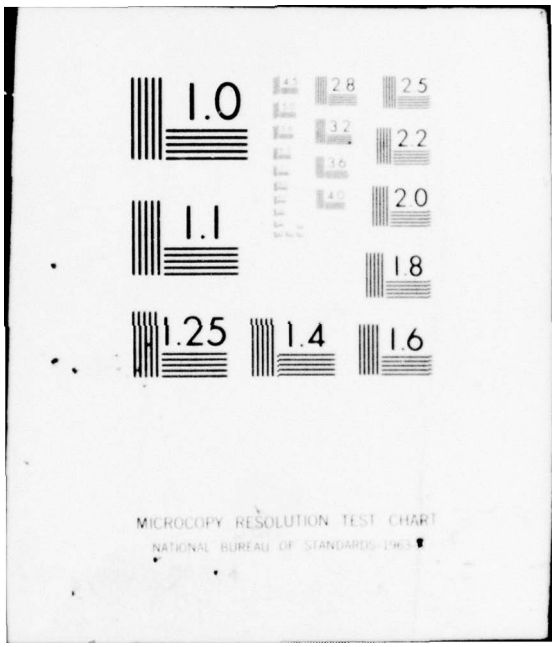
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1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
VAR016     PERCENT APPLIED INTERNALLY FUNDED
     CODE
                I
     1.00  ***  (      8)
           I  UNDER 20
           I
     2.00  *  (      1)
           I  20 TO 39
           I
     3.00  ***  (      8)
           I  40 TO 59
           I
     4.00  ***  (      6)
           I  60 TO 79
           I
     5.00  **********************************  (    121)
           I  OVER 80
           I
        0  **  (      3)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0         40        80        120       160       200
           FREQUENCY


MEAN            4.604      STD ERR          .086      MEDIAN          4.905
MODE            5.000      STD DEV         1.032      VARIANCE        1.066
KURTOSIS        6.002      SKEWNESS       -2.672      RANGE           4.000
MINIMUM         1.000      MAXIMUM         5.000      SUM           663.000
C.V. PCT       22.425      .95 C.I.        4.434           TO         4.774

VALID CASES       144      MISSING CASES       3
```

```
VAR017    PERCENT DEVELOPMENT INTERNALLY FUNDED
     CODE
          I
     1.00 *** (      6)
          I  UNDER 20
          I
     2.00 ** (       3)
          I  20 TO 39
          I
     3.00 ** (       3)
          I  40 TO 59
          I
     4.00 *** (      6)
          I  60 TO 79
          I
     5.00 ********************************** (    127)
          I  OVER 80
          I
        0 ** (       2)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY

MEAN          4.690      STD ERR        .078      MEDIAN        4.929
MODE          5.000      STD DEV        .939      VARIANCE       .882
KURTOSIS      8.644      SKEWNESS     -3.132      RANGE         4.000
MINIMUM       1.000      MAXIMUM       5.000      SUM         680.000
C.V. PCT     20.028      .95 C.I.      4.535           TO       4.844

VALID CASES     145      MISSING CASES     2
```

```
VAR018    PRIMARY ASSIGNMENT CRITERION
     CODE
          I
     1.00 ******** (    14)
          I  MGMT    EXPERT
          I
     2.00 ****************************************** (    69)
          I  IN-HOUSE TECHNOL
          I
     3.00 ***** (     7)
          I  FORM    GROUP
          I
     4.00 ** (     1)
          I  SUPPORT PERS
          I
     5.00 ** (     1)
          I  OUTSIDE MGMT
          I
     6.00 ****** (     9)
          I  OUTSIDE TECHNOL
          I
     7.00 ********************** (    37)
          I  IN-HOUSE TRAIN
          I
     8.00 ***** (     8)
          I  OTHER
          I
        0 ** (     1)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         20        40        60        80        100
          FREQUENCY
```

MEAN	3.829
MODE	2.000
KURTOSIS	-1.560
MINIMUM	1.000
C.V. PCT	65.168
VALID CASES	146
STD ERR	.206
STD DEV	2.495
SKEWNESS	.495
MAXIMUM	8.000
.95 C.I.	3.421
MISSING CASES	1
MEDIAN	2.355
VARIANCE	6.226
RANGE	7.000
SUM	559.000
TO	4.237

```
VAR019     HIGHEST PRIORITY CRITERION
     CODE
           I
     1.00 ************** (     25)
           I  REDUCE  COSTS
           I
     2.00 ****** (     10)
           I  TIME-   LINESS
           I
     3.00 ****************************************** (     79)
           I  COMPET  POSIT
           I
     4.00 *** (      4)
           I  PROB    SUCCESS
           I
     7.00 ******* (     11)
           I  COMPANY GROWTH
           I
     8.00 ********* (     16)
           I  OTHER
           I
        0 ** (      2)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY


MEAN           3.469      STD ERR          .178      MEDIAN         2.975
MODE           3.000      STD DEV         2.138      VARIANCE       4.570
KURTOSIS        .158      SKEWNESS        1.111      RANGE          7.000
MINIMUM        1.000      MAXIMUM         8.000      SUM          503.000
C.V. PCT      61.627      .95 C.I.        3.118           TO        3.820

VALID CASES      145      MISSING CASES     2
```

```
VAR020     BUDGET COMMITTED
     CODE
            I
     1.00 ****************************************** (    71)
            I  PLANNING PHASE
            I
     2.00 ********* (    15)
            I  SALES   EST
            I
     3.00 ************** (    23)
            I  PROFIT  EST
            I
     4.00 ********* (    16)
            I  FUNDS   AVAIL
            I
     5.00 *********** (    19)
            I  OTHER
            I
        0 *** (     3)
(MISSING) I
            I
            I.........I.........I.........I.........I.........I
            0        20        40        60        80       100
            FREQUENCY
```

MEAN	2.285	STD ERR	.124	MEDIAN	1.567
MODE	1.000	STD DEV	1.490	VARIANCE	2.219
KURTOSIS	-1.040	SKEWNESS	.676	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	329.000
C.V. PCT	65.201	.95 C.I.	2.039	TO	2.530

VALID CASES	144	MISSING CASES	3

```
VAR021     EQUIPMENT ACQUISITION MODE
     CODE
               I
     1.00 ***************************** (    50)
               I  PURCHASE GENERAL
               I
     2.00 ****************************************** (    75)
               I  PURCHASE SPEC.
               I
     3.00 ** (     2)
               I  TRANSFER WITHIN
               I
     4.00 ****** (    10)
               I  DEVELOP IN-HOUSE
               I
     5.00 **** (     6)
               I  OTHER
               I
          0 *** (     4)
(MISSING)  I
               I
               I.........I.........I.........I.........I.........I
               0         20        40        60        80        100
               FREQUENCY
```

MEAN	1.930	STD ERR	.085	MEDIAN	1.787
MODE	2.000	STD DEV	1.012	VARIANCE	1.023
KURTOSIS	2.124	SKEWNESS	1.533	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	276.000
C.V. PCT	52.410	.95 C.I.	1.763	TO	2.097

VALID CASES	143	MISSING CASES	4

```
VAR022    REPROGRAMMING CRITERION
     CODE
           I
     1.00 ************************* (    45)
           I  NEW IDEA
           I
     2.00 *** (     4)
           I  PROJECT FAILURE
           I
     3.00 ********************************************** (    87)
           I  PERIODIC REVIEW
           I
     4.00 *** (     3)
           I  COMPET  EFFORT
           I
     5.00 *** (     4)
           I  OTHER
           I
        0 *** (     4)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0        20        40        60        80       100
           FREQUENCY
```

MEAN	2.420	STD ERR	.087	MEDIAN	2.759
MODE	3.000	STD DEV	1.044	VARIANCE	1.090
KURTOSIS	-.681	SKEWNESS	-.195	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	346.000
C.V. PCT	43.156	.95 C.I.	2.247	TO	2.592

VALID CASES 143 MISSING CASES 4

```
VAR023    PERSONNEL SELECTION
     CODE
               I
     1.00 ******* (    12)
               I  SPECIFIC HIRED
               I
     2.00 ****************** (    32)
               I  PAST    PERFORM
               I
     3.00 ********************************************** (    85)
               I  PERM    STAFF
               I
     4.00 ****** (     9)
               I  SPECIFIC TECHNOL
               I
     5.00 **** (     6)
               I  OTHER
               I
        0 *** (     3)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY
```

MEAN	2.757	STD ERR	.071	MEDIAN	2.829
MODE	3.000	STD DEV	.855	VARIANCE	.731
KURTOSIS	.937	SKEWNESS	.082	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	397.000
C.V. PCT	31.006	.95 C.I.	2.616	TO	2.898

VALID CASES 144 MISSING CASES 3

```
VAR024    PERCENT BASIC SUBCONTRACTED
     CODE
          I
     1.00 ****************************** (   103)
          I  UNDER 5
          I
     2.00 ***** (    14)
          I  5-25
          I
     3.00 ** (     5)
          I  26-50
          I
     4.00 ** (     3)
          I  51-75
          I
     5.00 *** (     9)
          I  76-100
          I
        0 **** (    13)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY

MEAN          1.515      STD ERR        .098      MEDIAN        1.150
MODE          1.000      STD DEV       1.129      VARIANCE      1.274
KURTOSIS      3.879      SKEWNESS      2.261      RANGE         4.000
MINIMUM       1.000      MAXIMUM       5.000      SUM         203.000
C.V. PCT     74.513      .95 C.I.      1.322           TO      1.708

VALID CASES     134      MISSING CASES    13
```

```
VAR025    PERCENT APPLIED SUBCONTRACTED
     CODE
          I
     1.00 ******************************** (   111)
          I  UNDER 5
          I
     2.00 ****** (    20)
          I  5-25
          I
     3.00 *** (     7)
          I  26-50
          I
     5.00 ** (     5)
          I  76-100
          I
        0 ** (     4)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY
```

MEAN	1.378	STD ERR	.073	MEDIAN	1.144
MODE	1.000	STD DEV	.871	VARIANCE	.758
KURTOSIS	8.295	SKEWNESS	2.854	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	197.000
C.V. PCT	63.190	.95 C.I.	1.234	TO	1.522

VALID CASES	143	MISSING CASES	4

```
VAR026     PERCENT DEVELOPMENT CONTRACTED
     CODE
           I
     1.00  ****************************** (   113)
           I  UNDER 5
           I
     2.00  ****** (    20)
           I  5-25
           I
     3.00  ** (     5)
           I  26-50
           I
     4.00  * (      1)
           I  51-75
           I
     5.00  ** (     5)
           I  76-100
           I
        0  ** (     3)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0         40        80        120       160       200
           FREQUENCY
```

MEAN	1.368	STD ERR	.073	MEDIAN	1.137
MODE	1.000	STD DEV	.875	VARIANCE	.766
KURTOSIS	8.516	SKEWNESS	2.921	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	197.000
C.V. PCT	63.962	.95 C.I.	1.224	TO	1.512

VALID CASES	144	MISSING CASES	3

```
VAR027    EXTERNALLY FUNDED GOVT BASIC
   CODE
                I
     1.00 ********************************* (    121)
          I  UNDER 5
          I
     2.00 ** (      2)
          I  5-25
          I
     3.00 ** (      3)
          I  26-50
          I
     4.00 * (       1)
          I  51-75
          I
     5.00 *** (      6)
          I  76-100
          I
        0 ***** (     14)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY


MEAN           1.263      STD ERR          .079      MEDIAN         1.050
MODE           1.000      STD DEV          .912      VARIANCE        .832
KURTOSIS      10.842      SKEWNESS        3.488      RANGE          4.000
MINIMUM        1.000      MAXIMUM         5.000      SUM          168.000
C.V. PCT      72.200      .95 C.I.        1.107           TO        1.420

VALID CASES      133      MISSING CASES     14
```

```
VAR028    EXTERNALLY FUNDED GOVT APPLIED
     CODE
          I
     1.00 ****************************** (   111)
          I  UNDER 5
          I
     2.00 *** (     9)
          I  5-25
          I
     3.00 ** (     5)
          I  26-50
          I
     4.00 ** (     4)
          I  51-75
          I
     5.00 ** (     5)
          I  76-100
          I
        0 **** (    13)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY
```

MEAN	1.381	STD ERR	.084	MEDIAN	1.104
MODE	1.000	STD DEV	.972	VARIANCE	.944
KURTOSIS	6.213	SKEWNESS	2.683	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	185.000
C.V. PCT	70.386	.95 C.I.	1.215	TO	1.547
VALID CASES	134	MISSING CASES	13		

```
VAR029    EXTERNALLY FUNDED GOVT DEVELOPMENT
     CODE
          I
     1.00 ****************************** (   111)
          I  UNDER 5
          I
     2.00 **** (    10)
          I  5-25
          I
     3.00 ** (     4)
          I  26-50
          I
     4.00 ** (     4)
          I  51-75
          I
     5.00 *** (     7)
          I  76-100
          I
        0 **** (    11)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY
```

MEAN	1.426	STD ERR	.090	MEDIAN	1.113
MODE	1.000	STD DEV	1.052	VARIANCE	1.106
KURTOSIS	5.218	SKEWNESS	2.535	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	194.000
C.V. PCT	73.714	.95 C.I.	1.248	TO	1.605

VALID CASES	136	MISSING CASES	11

```
VAR030     EXTERNALLY FUNDED COMM BASIC
     CODE
           I
     1.00  ********************************** (   122)
           I  UNDER 5
           I
     2.00  ** (     2)
           I  5-25
           I
     3.00  ** (     3)
           I  26-50
           I
     5.00  ** (     4)
           I  76-100
           I
        0  ***** (    16)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I.........I
           0         40        80        120       160       200
           FREQUENCY
```

MEAN	1.183	STD ERR	.066	MEDIAN	1.037
MODE	1.000	STD DEV	.752	VARIANCE	.566
KURTOSIS	18.343	SKEWNESS	4.364	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	155.000
C.V. PCT	63.594	.95 C.I.	1.053	TD	1.313

VALID CASES	131	MISSING CASES	16

```
VAR031    EXTERNALLY FUNDED COMM APPLIED
     CODE
          I
     1.00 ********************************** (   121)
          I  UNDER 5
          I
     2.00 ** (     5)
          I  5-25
          I
     3.00 ** (     3)
          I  26-50
          I
     5.00 *** (     6)
          I  76-100
          I
        0 **** (    12)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY
```

MEAN	1.259	STD ERR	.076	MEDIAN	1.058
MODE	1.000	STD DEV	.881	VARIANCE	.776
KURTOSIS	12.055	SKEWNESS	3.617	RANGE	4.000
MINIMUM	1.000	MAXIMUM	5.000	SUM	170.000
C.V. PCT	69.935	.95 C.I.	1.109	TO	1.409

VALID CASES	135	MISSING CASES	12

```
VAR032    EXTERNALLY FUNDED COMM DEVELOPMENT
     CODE
          I
     1.00 ********************************* (   120)
          I  UNDER 5
          I
     2.00 *** (     7)
          I  5-25
          I
     3.00 ** (      3)
          I  26-50
          I
     4.00 ** (      3)
          I  51-75
          I
     5.00 ** (      4)
          I  76-100
          I
        0 **** (    10)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         40        80        120       160       200
          FREQUENCY

MEAN          1.277      STD ERR        .073      MEDIAN        1.071
MODE          1.000      STD DEV        .855      VARIANCE       .731
KURTOSIS     10.324      SKEWNESS      3.331      RANGE         4.000
MINIMUM       1.000      MAXIMUM       5.000      SUM         175.000
C.V. PCT     66.948      .95 C.I.      1.133           TO       1.422

VALID CASES     137      MISSING CASES    10
```

```
VAR033     TREND GOVT BASIC
     CODE
            I
     1.00 ******* (     11)
            I  INCREASE
            I
     2.00 *********** (     19)
            I  DECREASE
            I
     3.00 *** (      4)
            I  VARIED
            I
     4.00 ******************************************** (     79)
            I  STABLE
            I
        0 ******************* (     34)
(MISSING)   I
            I
            I.........I.........I.........I.........I.........I
            0         20        40        60        80        100
            FREQUENCY


MEAN            3.336       STD ERR          .101       MEDIAN          3.785
MODE            4.000       STD DEV         1.074       VARIANCE        1.154
KURTOSIS        -.268       SKEWNESS       -1.177       RANGE           3.000
MINIMUM         1.000       MAXIMUM         4.000       SUM           377.000
C.V. PCT       32.195       .95 C.I.        3.136            TO         3.536

VALID CASES       113       MISSING CASES     34
```

```
VAR034     TREND GOVT APPLIED
     CODE
           I
     1.00 ********** (     17)
           I  INCREASE
           I
     2.00 ********* (     15)
           I  DECREASE
           I
     3.00 *** (      4)
           I  VARIED
           I
     4.00 ****************************************** (     79)
           I  STABLE
           I
        0 ***************** (     32)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0         20        40        60        80        100
           FREQUENCY

MEAN            3.261      STD ERR          .108      MEDIAN          3.772
MODE            4.000      STD DEV         1.163      VARIANCE        1.352
KURTOSIS        -.553      SKEWNESS       -1.091      RANGE           3.000
MINIMUM         1.000      MAXIMUM         4.000      SUM           375.000
C.V. PCT       35.663      .95 C.I.        3.046           TO         3.476

VALID CASES       115      MISSING CASES     32
```

```
VAR035    TREND GOVT DEVELOPMENT
     CODE
           I
     1.00 *************** (    25)
           I  INCREASE
           I
     2.00 ******* (    11)
           I  DECREASE
           I
     3.00 ***** (     7)
           I  VARIED
           I
     4.00 ****************************************** (    74)
           I  STABLE
           I
        0 ***************** (    30)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0        20        40        60        80       100
           FREQUENCY

MEAN          3.111     STD ERR        .116     MEDIAN        3.709
MODE          4.000     STD DEV       1.258     VARIANCE      1.582
KURTOSIS     -1.057     SKEWNESS      -.863     RANGE         3.000
MINIMUM       1.000     MAXIMUM       4.000     SUM         364.000
C.V. PCT     40.433     .95 C.I.      2.881           TO      3.341

VALID CASES     117     MISSING CASES    30
```

```
VAR036     TREND COMERCIAL BASIC
     CODE
           I
     1.00 ******** (     13)
           I  INCREASE
           I
     2.00 ******** (     13)
           I  DECREASE
           I
     3.00 **** (      5)
           I  VARIED
           I
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(MISSING) I
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           FREQUENCY

MEAN           3.381      STD ERR          .102      MEDIAN         3.811
MODE           4.000      STD DEV         1.080      VARIANCE       1.166
KURTOSIS        .158      SKEWNESS       -1.355      RANGE          3.000
MINIMUM        1.000      MAXIMUM         4.000      SUM          382.000
C.V. PCT      31.948      .95 C.I.        3.179           TO        3.582

VALID CASES      113      MISSING CASES     34
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     2.00  ***** (     7)
           I  DECREASE
           I
     3.00  ***** (     7)
           I  VARIED
           I
     4.00  ********************************************** (    82)
           I  STABLE
           I
        0  ***************** (    29)
(MISSING)  I
           I
           I.........I.........I.........I.........I.........I
           0        20        40        60        80        100
           FREQUENCY

MEAN          3.263      STD ERR        .111      MEDIAN        3.780
MODE          4.000      STD DEV       1.201      VARIANCE      1.443
KURTOSIS      -.439      SKEWNESS     -1.169      RANGE         3.000
MINIMUM       1.000      MAXIMUM       4.000      SUM         385.000
C.V. PCT     36.820      .95 C.I.      3.044           TO      3.482

VALID CASES     118      MISSING CASES    29
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     2.00 ******* (     12)
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            I
     3.00 ***** (      7)
            I  VARIED
            I
     4.00 ****************************************** (     76)
            I  STABLE
            I
        0 ************** (     25)
(MISSING)   I
            I
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            FREQUENCY
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MEAN	3.082	STD ERR	.115	MEDIAN	3.697
MODE	4.000	STD DEV	1.270	VARIANCE	1.613
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MINIMUM	1.000	MAXIMUM	4.000	SUM	376.000
C.V. PCT	41.209	.95 C.I.	2.854	TO	3.310

VALID CASES	122	MISSING CASES	25

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          I
     5.00 ******************* (    17)
          I  NEW     PROCESS
          I
     6.00 ************************** (    25)
          I  MARKET  SHARE
          I
     7.00 ***************************************** (    37)
          I  OTHER
          I
        0 *** (     2)
(MISSING) I
          I
          I.........I.........I.........I.........I.........I
          0         10        20        30        40        50
          FREQUENCY

MEAN          4.234      STD ERR        .205      MEDIAN        4.882
MODE          1.000      STD DEV       2.464      VARIANCE      6.070
KURTOSIS     -1.545      SKEWNESS      -.325      RANGE         6.000
MINIMUM       1.000      MAXIMUM       7.000      SUM         614.000
C.V. PCT     58.181      .95 C.I.      3.830           TO       4.639

VALID CASES     145      MISSING CASES     2
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